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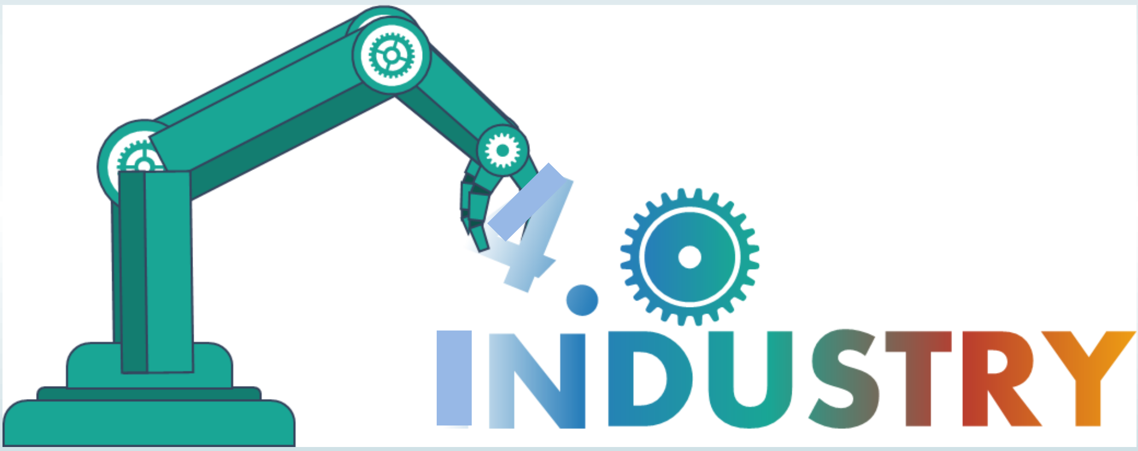

Possibilities and barriers for Industry 4.0 implementation in SMEs in V4 countries and Serbia

2022

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CONTENT

INTRODUCTION TO THE VISEGRAD FUND PROJECT: POSSIBILITIES AND BARRIERS FOR INDUSTRY 4.0 IMPLEMENTATION IN SMEs IN V4 COUNTRIES AND SERBIA

Ivan Mihajlović[1], Isidora Milošević[1], Danijela Voza[1], Sanela Arsić[1]
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International research project "*Possibilities and barriers for Industry 4.0 implementation in SMEs in V4 countries and Serbia*" is financially supported by the Visegrad Fund. The serial number of the project is 22110036.

Project description: Modern technologies based on Industry 4.0 change the business environment, especially in SMEs. This opens a new field in research and possibilities for continuing and strengthening academic collaboration among partner institutions in Visegrad countries (V4) and Serbia which the focus would be on acceptance of Industry 4.0 concepts in SMEs.

Digitalization and concepts of Industry 4.0 are still insufficiently known in the business environment, especially in the SMEs sector in Serbia. Experiences in applying the advanced technologies in the frame of Industry 4.0 from V4 countries will be a good example to SMEs in Serbia, for their future development and better competitiveness in the EU market. The willingness of SMEs to accept the Industry 4.0 concept depends on the levels of understanding of the benefits among entrepreneurs, scientists, and practitioners.

In the previous project cycle, funded by the Visegrad fund, the research was completed, focusing on the factors influencing SME failure and the possibility of their recovery in Visegrad countries (V4) and Serbia. Based on the obtained results, it was concluded that one of the most significant factors that cause SME failure is the lack of knowledge and experience in the process of implementation of technologies based on Industry4.0 in business.

Considering that modern concepts and technologies are dramatically changing business circumstances, this project aims to develop a small, practical, software solution that can be adapted to the needs of decision-makers in small and medium enterprises. The application will use the database created during our previous and current research project and will allow decision-makers to assess their present business process, based on the most influential factors. This will enable the management of SMEs in V4 and Serbia to recognize the opportunities and overcome threats by the support of a user-friendly ICT tool, developed on the concept of open sources available in the frame of the Industry 4.0 concept. Continuing and strengthening academic collaboration in V4 and Serbia, an international and interdisciplinary research network will be created, aimed to explore possibilities for using an implementation of the Industry 4.0 concept in entrepreneurship. The project will be focused on adopting the best available practices from Visegrad countries, whereby Serbian lecturers will further transfer this knowledge to the students as future managers of SMEs and to the current entrepreneurs.

The overall objective of the project is to contribute to the economic and technological development of Serbia through the advancement of academic and entrepreneurial cooperation, transfer of knowledge, expertise, and best practice by V4 countries in the field of Industry 4.0 in business.

The specific goals are: identifying the needs, possibilities, and barriers for digitalization and Industry 4.0 implementation in SMEs in V4 and Serbia; Creating specific concepts and strategies for intelligent and flexible SMEs business model based on Industry 4.0; Developing the methodological approach which will be applied in practice; Designing a business software tool for strategic decision-making in accordance with the concepts of available open sources of Industry 4.0, which will be customized to the needs of managers, SME owners, entrepreneurs, and academic institutions for student's needs; Introducing a special field of Industry 4.0 applications within the existing courses in the curriculum of TFB, EMD.

Partners: Official V4 partners that participated in project activities and research are:

1. Obuda University, Keleti Faculty of Business and Management, Hungary: www.uni-obuda.hu
2. The University of St. Cyril and Methodius, Slovakia, www.ucm.sk
3. The University of Economics in Katowice, Poland, www.ue.katowice.pl
4. Tomas Bata University in Zlin, Czech Republic: www.utb.cz

Planned Events of the Project

June, 2021: The initial online meeting of project participants was organized online through the Zoom platform. At this meeting are participated all partners' institutions from V4 and Serbia. It was carried out the distribution of the project tasks and activities among the project consortium members. During the online meeting, it was proposed ways for collecting data, based on which all partner institutions conducted the desk and field research in order to determine the possibilities and barriers of SMEs for Industry 4.0 acceptance in Visegrad countries and Serbia. Also, this meeting defined activities for developing a methodological framework and designing the software solution.

June – August, 2021: After the successful initial meeting, the project member teams from V4 and Serbia who according to the project plan were to be engaged for research reviewed the scientific literature and carried out an investigation. Based on the created online questionnaire, the survey was distributed to SMEs for data collection. The entrepreneurs were selected and interviewed about their experience and intention using digitalization and digital available open source technologies for their business operations. After collecting data in all partner countries, the database was updated. All team members received a database and based on that they performed statistical data processing.

October, 2021: Participants from Serbia and all V4 partners visited the Innovative entrepreneurial center in Budapest in Hungary. Additionally, a meeting with all project participants was held, where the project members presented the results of the research carried out in the previous project stage. The participants of the project from Hungary were the host and presented their region which is a start-up hub with a special emphasis on tech entrepreneurs. After the visit and meeting with representatives from Obuda University in Budapest, participants from Serbia, and other V4 partner countries exchanged experiences about tech entrepreneurship and successful SMEs in their countries. Serbian participants will transfer newly acquired knowledge from the Innovative entrepreneurial center in Hungary to their students as future managers of SMEs, as well as existing entrepreneurs in Serbia.

September – November, 2021: Based on the analysis of research results described in the previous phase, the applicant from Serbia developed an original integrated methodological approach to provide the potential for transferring Industry 4.0 concepts to SMEs, in terms of digitizing their business activities, using available open source tools. Developed the original integrated methodological framework was used as a good basis for the design of the business software solution for strategic decision making in the business operations by applying the available open-source concepts of Industry 4.0. This designed software solution will be a potential step forward in optimization of the SMEs practices, as a SaaS solution (software as a service) that will adapt to different end-user needs, based on the available open-source tools. Taking into account that existing similar software solutions are too expensive, complicated for use, and available only for the big companies, this software solution will facilitate the support for the decision-making process in SMEs, and get them familiar with the modern concepts of Industry 4.0 in their business environment.

December 2021 – March, 2022: The obtained results of the conducted research on Industry 4.0 in entrepreneurship were presented in the form of the Monograph and one special issue of the Serbian Journal of Management (SJM) (http://www.sjm06.com/). This publication in the form of the monograph has consisted of a theoretical approach to the concept of Industry 4.0 and its implementation in entrepreneurship. Also, the developed innovative integrated methodological concept has been presented. The results obtained by the project research in all project countries have been summarized in the form of scientific articles and published in the special issue in the SJM, dedicated to the Industry 4.0 concepts and applications. The authors of the articles were participants from all Visegrad countries (Czech Republic, Slovak, Polish, and Hungary) and Serbia, and the wider academic community.

June, 2022: A Final Report will be prepared by the project manager in the cooperation of other project members from Serbia. The final report will consist of the summary results of the whole project, the final budget, different aspects of the implementation, and the role of the partners in the cooperation.

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INDUSTRY 4.0 DEVELOPMENT AND IMPLEMENTATION IN SMEs IN POLAND

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Abstract

Industry 4.0 encompasses different processes, such as robotics, Internet of Things, big data, artificial intelligence, and others. Therefore, researching implementation of Industry 4.0 remains a difficult task. The study aimed at providing better insights into barriers and benefits of Industry 4.0 implementation in Poland. The results showed that almost 40% of participants are familiar with the term Industry 4.0. In the researched group, senior managers were the most educated (46%), while owners turned out to be the least educated (36%). Among the processes of Industry 4.0, artificial intelligence is the most recognized (86% have heard or use it), while the least recognized is augmented reality (62% have heard or use it). The results showed that companies perceive the Industry 4.0 digitalization processes as an element of resource optimization and reduction (over 60% companies). The benefits of digitalization were measured in financial, operational, and strategic areas. No less than half of participants described the benefits as positive to the organization in all the researched areas. Human, financial, and technology resources were indicated as the most important internal limitations to digitalization, and the internet, lack of experienced service providers, and lack of external funds were referred to as external limitations. The study also enhanced the Industry 4.0 concept by providing the perspective of the use of professional social

networks, professional communication tools, and social networking for business purposes. The study showed that there are still significant barriers to the development of digitalization processes for Industry 4.0 in Poland, and more efforts should be channeled into educational policy.
Keywords: *Industry 4.0, Implementation, Poland, Small and medium sized entities, SME*

1. INTRODUCTION

The Industry 4.0 concept is spreading all over the world. Industry 4.0 is defined as the fourth industrial revolution, which, after a period of increased IT and computer technology development to automate processes (Industry 3.0), implements more advanced processes based on automation and digitalization (cyber-physical systems) into the operations of enterprises. In this context, the traditionally understood processes of globalization, based on the free flows of capital, people and other resources, are changing towards focusing on the "world" of digitalized processes, implemented to a high degree of involvement of the IT environment. Companies change their behaviors and their perception of competition and competitiveness as a result of implementing new key technologies (Miśkiewicz, 2019).
There are different processes implemented under Industry 4.0 (e.g., 3D print, cyber-security, robotization, cloud computing, Internet of Things, systems integration, augmented reality, big data, autonomous robots, and others. Therefore, their common feature is the use of the digital environment. In such a context, these processes are naturally more advanced in large, international enterprises that have appropriate resources to carry out these activities. The production industry has priority given its specific nature.
At the same time, the digital world enters almost every area of our lives. This also applies to enterprises, both these operating in services and trade, as well as those from the SME sector or the public finance

sector. These processes are visible in different countries to a different degree of implementation.

Considering the role played by the SME sector in the economy, the main aim of this study was *to examine the degree of knowledge and significant characteristics, barriers of, and incentives to Industry 4.0 implementation in SME in Poland*. The following research questions were formulated:

1. What are the main barriers of the development of Industry 4.0 in the SME sector in Poland?
2. What are the most important benefits of implementing Industry 4.0 in the SME sector in Poland?
3. Is it possible to identify and what are the areas of business activities that are particularly important for development of Industry 4.0 in SME sector in Poland?

The following research methods were used in the study: literature studies, critical information analysis of materials included in industry reports, survey research, deduction and synthesis.

2. INDUSTRY 4.0 SOCIO-ECONOMIC AND POLITICAL INITIATIVES IN POLAND

2.1. Strategy for Sustainable Development (SSD)

The 2020 Strategy for Sustainable Development (SSD) (with a 2030 perspective) was adopted by the Polish Council of Ministers in 2017. SSD defines specific areas of the country's development and the challenges facing the Polish economy. These challenges were defined by the formula of “five development traps”, including: average income, imbalance, average product, demographic and institutional weakness. SSD aims at making the Polish economy more innovative, also in the area of digitalization. The focus of the strategy's activities on digitalization concerns re-industrialization, development of innovative companies, SMEs, e-state.

Digitalization is clearly distinguished as one of the six areas influencing the achievement of the Strategy objectives. The emphasis is on (Strategia, 2017, p. 10, 14, 74, 102-105, 242):

- Reindustrialization in the form of the development of new industries based on digital technologies (R&D, design, ICT);
- Increasing the innovativeness of enterprises on the domestic and international market, through R&D spending, financial support for innovative programs (e.g. medical engineering technologies, intelligent networks and geoinformation technologies, automation and robotics of technological processes);
- Structural changes, new forms of operation and cooperation as well as modern support instruments in the SME sector;
- Electronic service of citizens and entrepreneurs to increase the percentage of people using the internet in contacts with public administration.

Threats caused by digitalization are also highlighted in the strategy. One of the most important is a threat to the labor market, and the need to develop solutions that minimize the potential negative social impact of digitalization (Strategia, 2017, p. 9). SSD is systemic in nature, setting the directions and areas of transitional activities, including organizational and financial support. In this regard, the initiative of the Polish Platform "Industry 4.0" was also indicated, which is to support the process of industrial transition towards the digitization of technological and management processes in enterprises (Strategia, 2017, p. 73-74).

2.2. Polish Platform "Industry 4.0"

Industry 4.0 Polish platform operates as a foundation, although it is coordinated on the government level. It focuses on strengthening competency and competitiveness of Polish enterprises, Polish science, as well as education and society by supporting their transition towards Industry 4.0. There are activities related to promotion, training, conferences, establishing relationships and background for cooperation.

Companies are able to conduct a self-assessment of their digital maturity.
The foundation is also responsible for issuing opinions on legal acts related to the area of Industry 4.0 as well as for providing non-financial support for digital transition (www1).

2.3. Pilot of the Industry 4.0 program of the PARP

The Polish Agency for Enterprise Development (PARP) is one of the promoters of the development of the Industry 4.0 concept. PARP carries out a pilot of Industry 4.0 program among small and medium-sized entrepreneurs who conduct production activities.
As part of the program, companies can obtain funding for the creation of the so-called “Road map”, providing a plan to implement changes in the field of digitalization, robotization, and automation. The program is financed from the EU funds, the Intelligent Development Operational Program, in particular for the following technologies: Big Data, data analysis, industry robots, IoT industry, information technology and operational technology integration, cyber-physical systems, cyber-security, cloud computing, virtual reality, artificial intelligence, blockchain, 3D print (www2).

2.4. DIGINNO project

Poland is a member of the DIGINNO project (www3), developed by DIGINNO partner, Latvian Information and Communication Technologies Association (LIKTA) together with DIGINNO partners and financed under the project “DIGINNO of Interreg Baltic Sea Region”. The project is based on the methodology of the LIKTA initiative “Gudrā Latvija”, which implementation was launched in 2019. The scheme is coordinated in Poland by the Polish Chamber of Commerce for Electronics and Telecommunications. The partners are: Sweden, Lithuania, Poland, Estonia, Finland and Denmark.

This project focuses on the online digital maturity assessment tool for SMEs management level (board members, owners, development managers, CEOs), which enables to measure digital maturity of company across 10 business dimensions (digital transformation and competition, financial data management, human resources environment, customer relationship management, resource management, communication and customer relations, digitalization of processes, security policy and practices, innovation and growth perspectives).
Finally, after completing a questionnaire, the company will be placed within one of the four identified categories from the perspective of digital maturity: "champions' league", "sports starts", tool provides a possibility to compare with other firms as well as provides tips and directions for recommended activities for the development of digitalization.

3. PRIOR MANAGEMENT RESEARCH ON THE INDUSTRY 4.0 CONCEPT IN POLAND

In this section, we present the results of management research on Industry 4.0 based on research conducted in Poland or research in an international environment, but including Polish setting.
One of the most important areas of research on Industry 4.0 should be the effectiveness of the implementation of this concept, reflected in the company's achievements (including financial performance). Research in this area is limited. However, the work of Boichuk, (2020) can and should be mentioned here. Boichuk, (2020) recognized and appraised the advantages of current resolutions in the field of Industry 4.0 in automotive companies in the sector of small and medium enterprises. Based on the Industry 4.0 determinant appraisal carried out in an enterprise from the SME sector, it can be gathered that a company may attain many advantages by dint of such elements as automated machines, cyber-physical systems, big data, and cloud-based tools. The findings of that research showed that the capable use of technology can

substantially enhance the productivity of a manufacturing company. Furthermore, Ślusarczyk et al. (2020) supported that the following ingredients considerably affect the performance of logistics companies: current limited knowledge, preparing staff for challenges, implementation barriers, recognizing potentials, and Industry 4.0 implications.

The literature has also assessed the impact of Industry 4.0 on organizational solutions. Miśkiewicz et al. (2021) examined the key traits of teal organizations from the energy sector. The study condensed the core characteristics of teal organizations and their traits. Two hypotheses were verified:

- Innovations and technologies are the exceedingly applied traits among teal organizations from the energy sector;
- Organizational and corporate culture are the least applied traits among teal organizations from the energy sector.

The regression analysis outcomes indicated that an increase of 1% of patent applications led to an enhanced energy efficacy of 1.29%. Furthermore, the executed traits of teal organizations in the energy sector permitted the progress of the country's energy efficiency, which encouraged carbon-free development accordingly.

The implementation of the Industry 4.0 concept also influences the management methods used by enterprises. Dźwigoł, (2021) indicated research methods and techniques applied in management practice, while considering the assumptions of Industry 4.0. The research showed that the most significant methods, as reported by management professionals, were: observation, interview and documentation analysis. Nevertheless, the most regular utilized research techniques in practice include: analysis of business opinions, a probation period at the workplace, situation-related interview, knowledge test in a specific field, task-related behavior samples, task skills test, and analysis of informal client opinions.

Moreover and Wąchol, (2020) submitted chosen constituents of management, crucial for the prospective development (change trends) of enterprises, with reference to the global environment, process management, and ecology. The author found that there are some change trends in the management of prospective enterprises, modern technologies and good management of innovations that will be of significance here, as well as the growing recognition of ecology and sustainable development, in conjunction with waste recycling and searching for alternative and new energy sources.

An important element of managing a company that fits into Industry 4.0 is a patent policy. Klincewicz (2019) investigated patenting in the domain of robotics in Poland as the vital technological section encouraging the Industry 4.0 conversion. Klincewicz (2019) compared the conditions in Poland with global trends in robotics patenting. The investigation uncovered gaps in the acceptance for robotics in Poland, the insignificant prevalence, narrow inflow of locally prepared, inventive solutions and a marginal number of companies involved in patenting activities. According to Klincewicz (2019), the current inadequate advancement around the Industry 4.0 model unlocked possibilities for the forthcoming changes, inspiring private and public participants in the innovation system to pool intellectual and creative resources and pursue global directions with the purpose of reducing the gaps in the advancement and acceptance of these significant technologies. Based on these research findings, a rather limited number of innovative undertakings in robotics can be observed in Poland, with only 312 patent applications recorded between 2006 and 2015, and 173 patents granted based on these applications. The supremacy of public science is predominant (i.e., research institutes and universities).

The literature also provides comparative analyses of the situation of Industry 4.0 in Poland with other countries. Snieška et al. (2020) developed the diagnosis and comparison of the awareness of chosen risk concerns associated with Industry 4.0 execution in Slovak and Polish SMEs, which have awareness of or are familiar with cluster cooperation. Snieška et al. (2020) found that except for the type of risk called "New products and services", all the ascertained risks are recognized as higher by Slovak SMEs than by Polish SMEs. Miśkiewicz, (2019) emphasized the need to create in Poland an institution similar to the German Fraunhofer-Institute, which concentrates on innovation and new technologies.

The literature also examines the implementation of the Industry 4.0 concept in logistics processes. Twaróg et al. (2021) showed the higher than normal and utilitarian consequence of the multiple probabilistic traveling salesman problem (MPTSP) in the coordinating and modeling of sustainable product transportation, which was an originality at the theoretical, methodological and experimental level. Authors suggested a hybrid formula for solving MPTSP instances.

The results of these studies indicate the impact of the implementation of the Industry 4.0 concept on management systems. This does not mean that there are no research gaps in this area. The research gaps relate, in particular, to research on the development of business models, cost accounting systems and management accounting for the purposes of Industry 4.0, energy security management and many other issues. However, it can be concluded that the implementation of the Industry 4.0 concept has a significant impact on enterprise management systems.

4. GENERAL FACTORS FOR INDUSTRY 4.0 DEVELOPMENT IN POLAND

The level of digitalization and robotization, and consequently also the implementation of the Industry 4.0 concept, is measured by various indicators. In this regard, the following can be indicated:

- DESI (Digital Economy and Society Index), commissioned by the European Commission, for monitoring Member States' digital progress:
- NRI (Networked Readiness Index), initially launched in 2002 with the World Economic Forum, redesigned in 2019. Now the index is under the auspices of the Portulans Institute. It is global indices on the application and impact of information and communication technology (ICT) in economies around the world.

The results for Poland for the mentioned indicators are as follows:

- DESI 24/28 (average Poland 41; EU 50.7 for 2021);

- NRI 33/130 (2021).

These results show that in almost all areas of digital transition, Poland lags clearly behind other European Union Members.

Poland is situated within countries with the lowest results for DESI index, similar to Greece, Italy, Hungary, Cyprus, Bulgaria, Slovakia (Digital Economy and Society …, 2021, p. 19). The observation of changes over the years allows us to conclude that there is no significant digital transition taking place in Poland, and the place in this ranking is similar from year to year, also in terms of the detailed scopes of the analysis (Table 1). Polish companies do not have a strategy for digitalization, and digital technology integration (DTI is below the EU average). The lowest rank is for using the internet, dti, digitalized public services.

Table 1. Indicators of digital technology integration by companies

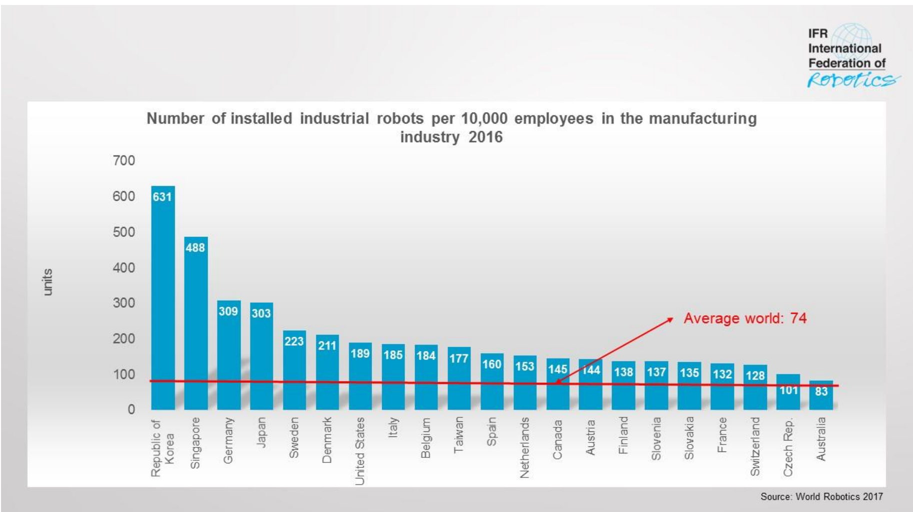
	Poland (DESI 2018)		EU (DESI 2018)
	Value	Place	Value
Percentage of companies	26%	22	34% (2017)
Radio identification	3.4%	20	4.2% (2017)
Use of social media	10% (2017)	26	21% (2017)
E-invoicing	13.2% (2017)	20	18% (2016)
Cloud computing	6.3% (2017)	25	18% (2018)
SME selling online	9.5% (2017)	24	17.2% (2017)
Turnover in e-commerce (SMEs turnover percentage)	6.6% (2017)	21	10.3% (2017)
Cross-border online sale (percentage of SME)	3.9% (2017)	26	8.4% (2017)

Source: Śledziewska & Włoch, (2020)

The worst situation is in the area of digital technology integration by companies. Polish companies, in particular small and medium-sized ones (and there are about 54 thousand of them in our country), less often use systems allowing for electronic information exchange or e-invoicing than an average European enterprise, they use cloud services less frequently and use social media much less frequently as marketing tools and a communication channel with clients. Polish SMEs are less willing to sell online, also abroad.

In the elements explored within NRI indicator the strongest are (www4): the population covered by at least 3G mobile network and internet access in schools (1), E-commerce legislation (1) as well as E-Participation (9). The weakest are for robot density (31), investment in emerging technologies (73) privacy protection by law content (74) and freedom to make life choices (89).

The most popular indicator which determines the degree of development and of automation/robotization is the so-called robot density (no of industry robots per 10000 workers in industrial plants).



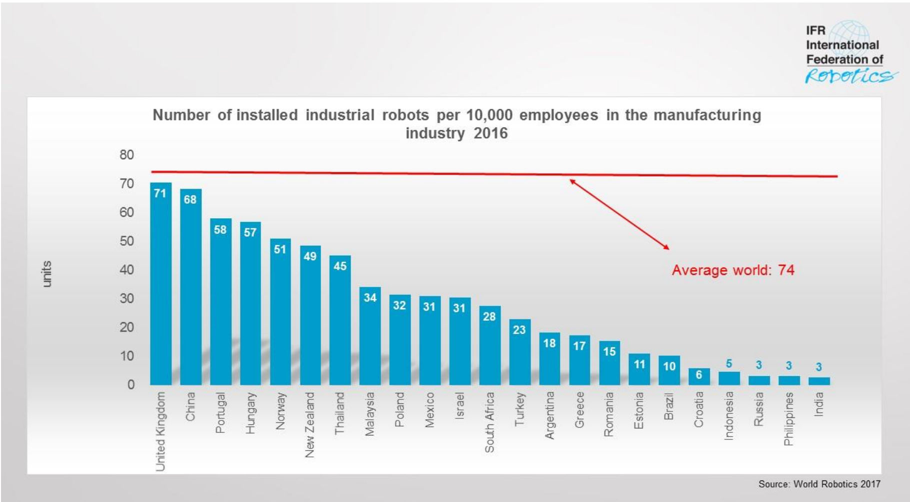


Figure 1. Robot density index over the world
Source: https://networkreadinessindex.org/country/poland/

According to the International Federation of Robotics, Poland ranks very low (Figure 1). In 2016, robot density in Poland was 32 (the world average - 74), in 2017 the amounted number of industrial robots was 11.000.

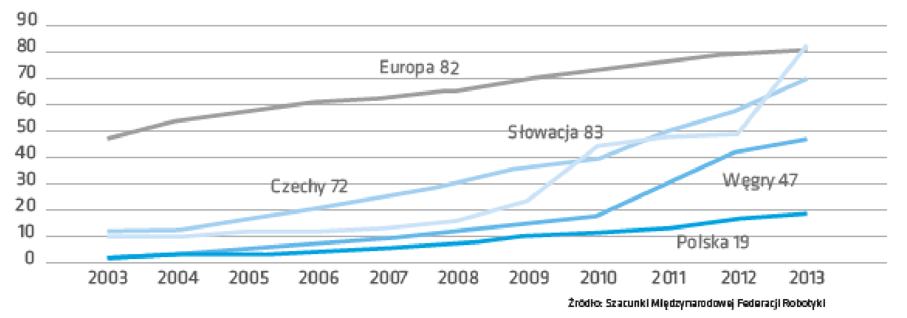


Figure 2. The dynamics of the increase in the number of industrial robots in the Visegrad countries as compared to the rest of Europe
Source: Michałowski et al. (2018)

Compared to the Visegrad countries, the situation in Poland is far from satisfactory. Other countries are aiming for the European average, while such a trend is not visible in Poland (Figure 2).
The main clients for robotics in Poland are foreign companies operating in Poland. Regarding the size of the Polish companies, the most active for purchasing robotics are medium-sized-(84%), big-(46%) and small (20%) manufacturing companies. Referring the type of industry, the main clients are from automotive industry, industry sector, electronic and computer industry, food industry, metallurgical industry.

5. INDUSTRY 4.0 IMPLEMENTATION IN POLAND – IN THE OPINION OF POLISH ENTREPRENEURS

The Industry 4.0 survey was divided into following parts: participant characteristics, company characteristics, use of digital technologies, digitalization benefits, and limitations, and Industry 4.0 characteristics. The survey was conducted from August 15th, 2020 to the October 31st, 2020 through an internet questionnaire on the Polish enterprises representing all sectors of the Polish economy. 101 responses were obtained (return rate approx. 3.5%). Basic characteristics of survey participants is shown in Table 2.
Over 80% of participants received Bachelor’s and higher level of education. The work experience was almost the same for the lowest experienced participants (up to 5 years) with the share of 41% and the most experienced participants (more than 20 years) with the share of 38%. Employees with work experience of 6 to 20 years constituted 22% of survey participants.
Participants from the age group of 18 to 30 were a group which was similar to the age group of 31 to 60 and accounted for 44% and 49%, respectively.
Gender share was evenly distributed with share of 50% for male and 49% for female participants. One answer was registered as other gender and one for a person who did not specify their gender.

Table 2. Basic characteristic of the participants

Variables	N	%
Age [years]		
18 – 30	44	44%
31 – 45	25	25%
46 – 60	24	24%
61 +	8	8%
Gender		
Male	50	50%
Female	49	49%
Other gender	1	1%
I do not wish to answer	1	1%
The position in the company		
The owner	25	25%
Senior manager	24	24%
Manager	9	9%
Employee	43	43%
The years of work experience		
Up to 5 years	41	41%
From 6 to 10 years	7	7%
From 11 to 20 years	15	15%
More than 20 years	38	38%
The level of education		
High school	18	18%
Bachelor	33	33%
Master	42	42%
Ph.D.	8	8%

The most held position in the company was registered as an employee with the share of 43%, while the managerial staff accounted for 33%. The owner positions were reported by 25% of the participants. Companies' characteristics are shown in Table 3.

Table 3. Companies characteristic

Variables	N	%
Number of employees		
up to 9	35	35%
10 – 49	26	26%
50 – 249	20	20%
more than 250	20	20%
Total assets		
less than 2 Mil €	51	50%
from 2 to less than 10 Mil €	25	25%
from 10 to less than 43 Mil €	11	11%
43 Mil € and above	14	14%
Annual revenue (turnover)		
less than 2 Mil €	50	50%
from 2 to less than 10 Mil €	25	25%
from 10 to less than 50 Mil €	12	12%
50 Mil € and above	14	14%
Company operates		
Up to 2 years	2	2%
From 3 to 5 years	11	11%
From 6 to 10 years	15	15%
From 11 to 20 years	17	17%
21 years and older	56	55%
Dominating sector		
Production	37	37%
Trade	13	13%
Services	51	50%
Business activity area		
Agriculture	2	2%
Machinery and equipment	8	8%
Construction and developers	5	5%
Wholesale and retail trade	12	12%

Information and communication	6	6%
Manufacturing	27	27%
Finance and insurance	19	19%
Industry including energy	2	2%
Other sector	20	20%
Business focused market		
Exclusively domestic market	40	40%
Mostly on the domestic market	31	31%
Equally on the domestic and foreign markets	14	14%
Mostly on the foreign market	8	8%
Our company is a multinational enterprise (MNE) – a member of a group of companies	8	8%

Over 75% of companies represented assets and revenue lower than 10 million euro. Over 60% of companies were also typical for the SME sector, with the number of employees less than 50.

The surprising observation was that over 50% of companies (55%) have been on the market for more than 20 years, while newly created companies (with less than 2 years of operational status) were represented by only 2% of observations.

The service sector was the dominant sector in the survey (50%), followed by the production sector, which accounted for 37% of the respondents, and the trade sector (13%).

The survey was dominated by companies operating on the domestic market (over 70%), with 40% operating exclusively on the domestic market, and 31% mostly on the domestic market.

Familiarity with the term “Industry 4.0” is presented in Figures 3, 4, and 5.

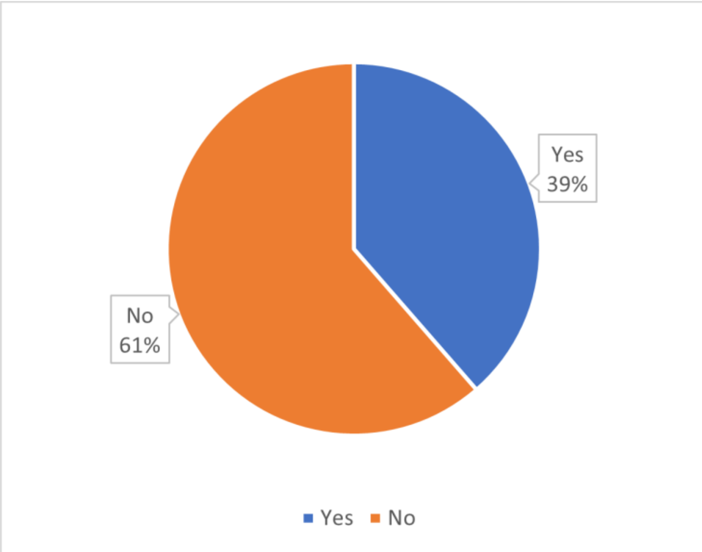


Figure 3. Industry 4.0 term familiarity

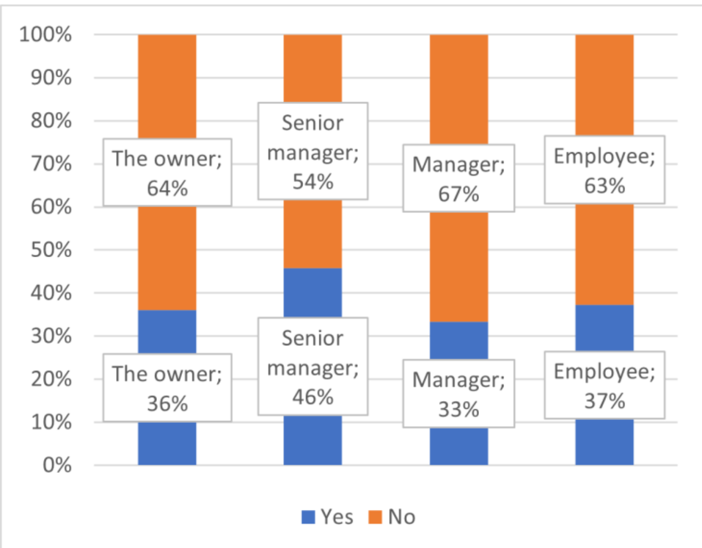


Figure 4. Industry 4.0 familiarity in the context of participant's company position

Almost 40% of participants were familiar with the term "Industry 4.0" (Fig. 3). Considering positions held in the company, the term "Industry 4.0" was the most recognized among Senior managers (46%), and other groups had similar recognition of "Industry 4.0": Employees – 37%, Owners – 36%, and Managers – 33%.

Figure 5. Familiarity with elements of Industry 4.0. Recognizable elements vs their usage

Familiarity with Industry 4.0 was displayed in Figure 5. Familiarity with the Industry 4.0 elements showed that the most recognizable element is Artificial intelligence (86%). However, the usage of AI was declared by only 25% of participants. The next similar recognition level was shown by 3D printing and robotics (84% with declared use by 21% participants), Supply chain management (81% with declared use by 25% participants), and Virtual reality (VR) (81% with declared use by 17% participants). Cloud computing services were also a well-known element of Industry 4.0, recognized by 74% of participants and 21% of participants declared its use. The least recognized elements of Industry 4.0 were Internet of Things (62% and declared use by 18% of participants), Augmented reality (AR) (62% and declared use by 10% of participants), and Big data analysis (58% and declared use by 12% of participants).

The concept of Industry 4.0 also relates to the issues of sustainability. The concept of sustainability is presented in the context of reducing the use of resources, reducing costs, reducing carbon emission, and achieving higher productivity and less waste. Opinions about the elements of sustainability are shown in the context of company revenue (Table 4, Figure 6).

Table 4. Digitalising the company helps to optimise and reduce the use of resources

Level of revenue	less than 2 Mil €	from 2 to less than 10 Mil €	from 10 to less than 50 Mil €	50 Mil € and above
Completely disagree	10%	8%	0%	0%
Disagree	8%	0%	0%	0%
Don't know	14%	20%	0%	7%
Agree	38%	56%	42%	21%
Completely agree	30%	16%	58%	71%
Total	100%	100%	100%	100%

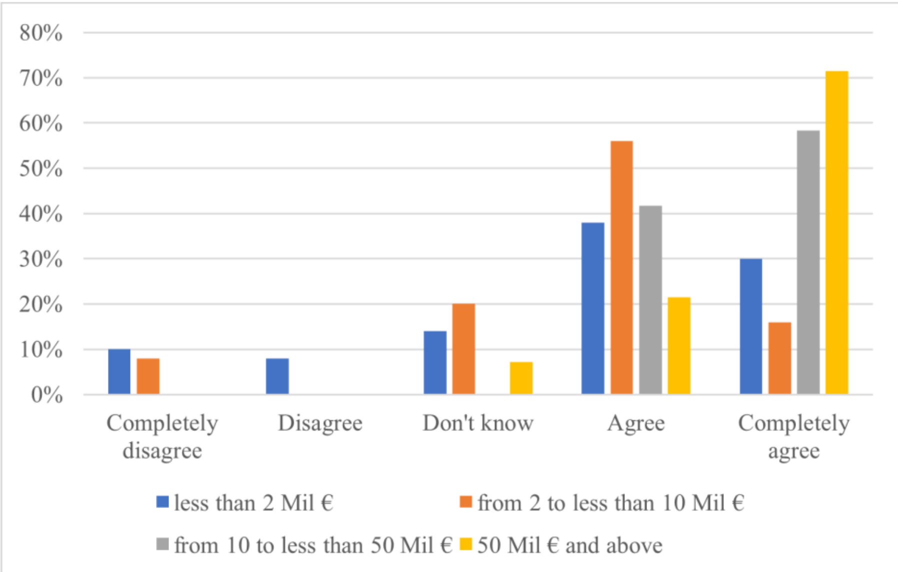
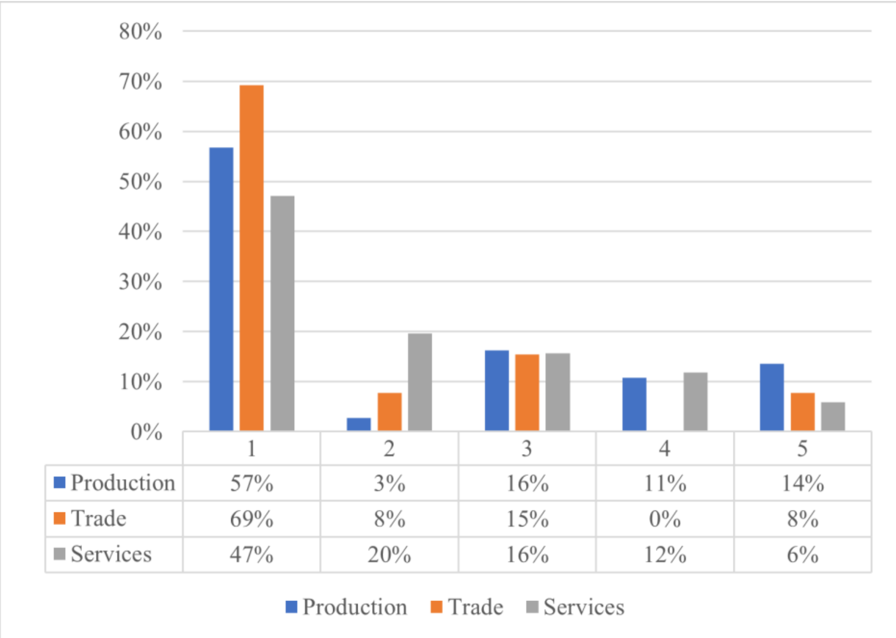


Figure 6. Digitalizing the company helps to optimize and reduce the use of resources

Independently of revenue, all the surveyed companies mostly perceived digitalization as an element of resource optimization and reduction (over 60% totally agrees and agrees). However, 18% of the SME companies completely disagreed and 8% disagreed with that statement.

Another natural consequence of Industry 4.0 implementation is the development of companies' network of connections based on the internet networks. This also includes the use of various applications relating to communication.

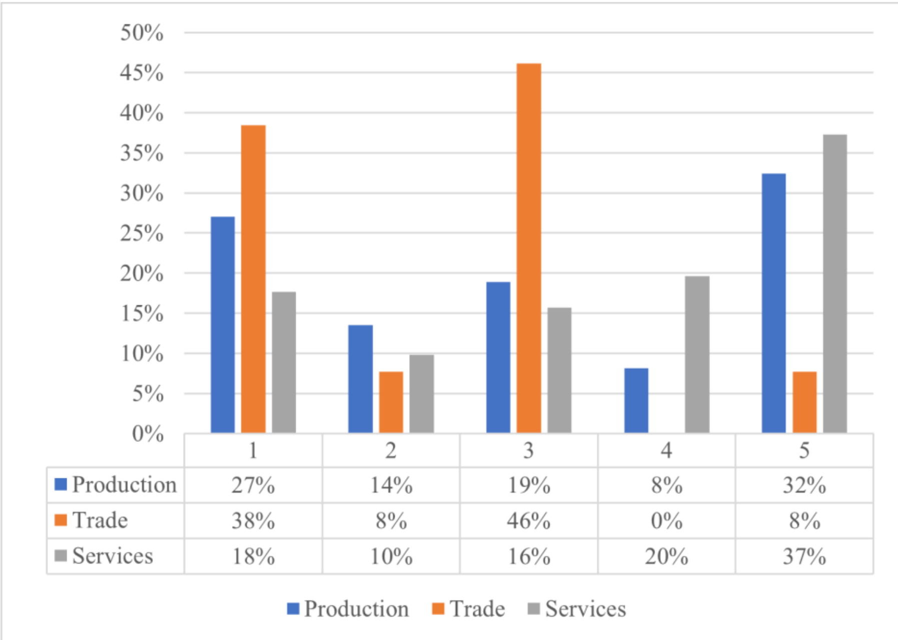
Use of social networks is presented in the context of a dominating sector. Figures 7, 8, and 9 represent the distribution of usage. Values [1, …, 5] represent the intensity of use from not at all (1) to daily (5).



	1	2	3	4	5
Production	57%	3%	16%	11%	14%
Trade	69%	8%	15%	0%	8%
Services	47%	20%	16%	12%	6%

Figure 7. Use of professional social networks (like LinkedIn)

The use of professional social networks is mostly not recognized by any of the sectors. The highest level of no use is presented by Trade sector (69%), with Production next in line (57%) and followed by Services (47%). In contrast, the highest level of usage (5 and 4) was indicated by companies from the Production sector (25%), and then followed by the Service sector (18%) and Trade with only 8%.



	1	2	3	4	5
Production	27%	14%	19%	8%	32%
Trade	38%	8%	46%	0%	8%
Services	18%	10%	16%	20%	37%

Figure 8. Use of professional communication tools (Google Meet, Zoom, Teams)

A different approach can be seen in the use of professional communication tools. The Service sector was leading in this respect with 57% of companies pointing to professional tools as being frequently in use (5, and 4), and the Production sector followed the leader with 40%. The Trade sector indicated the last use of communication tools. Only 8% of companies from this sector used them. The Trade sector was the one with the highest level of not using these tools too, 38% of companies did not use them at all. Among other sectors, 18% of companies from Services do not use communicational tools, and 27% in Production sector.

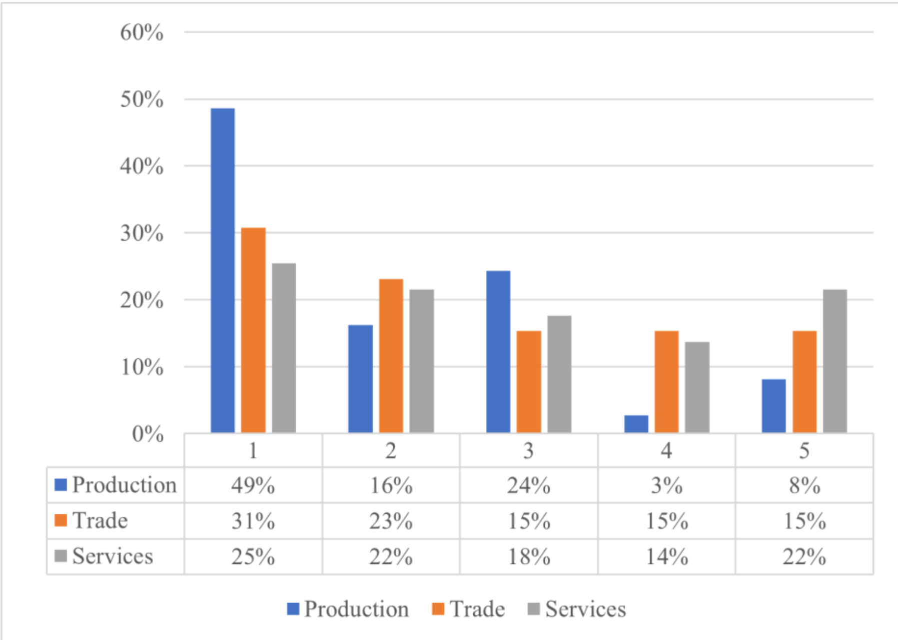


Figure 9. Use of social networking for business purposes (Facebook, Twitter, Instagram…)

The difference of use of social networks for business purposes becomes even more evident. These types of tools (values 4, and 5) are used mostly by companies from the Trade sector (30%), then followed by the Service sector (26%), and the Production sector as the last one with the score of 11%. The Production sector do not also use these types of tools at all (49% of companies), while Trade and Services showed similar behavior, 31% and 25% respectively.

The benefits of digitalization were analyzed in three performance areas: financial, operational, and strategic. The results are presented in Table 5.

Table 5. Benefits of digitalization

Performance:	Mean	Median	Mode	+/- SD	Q1	Q3	IQR	Distribution
Financial	3.57	4	4	1.22	3	4	1	
Operational	3.71	4	4	1.19	3	5	2	
Strategic	3.78	4	4 | 5	1.21	3	5	2	

In all three areas, no less than half of the participants pointed to the benefits of digitalization as positive to the organization (Median equals to 4). The most chosen answer was high (4) for financial and for operational performance and high and maximum (4 and 5) for strategic performance.
The most important limitations in achieving the best results from digitalization are presented in Table 6.

Table 6. The most important limitations of digitalisation

	Mean	Median	Mode	+/- SD	Q1	Q3	IQR
Internal limitations							
Limited technology resources	3.38	3	5	1.38	2	5	3
Limited finance	3.35	4	5	1.39	2	5	3
Human resources limitation	3.43	4	4	1.36	3	5	2
External limitations							
Internet	3.47	4	5	1.55	2	5	3
Lack of experienced service providers	3.11	3	3	1.31	2	4	2
Lack of external funds for such activity	3.14	3	4	1.41	2	4	2

The most pressing concerns in achieving the best results from digitalization in the perspective of internal limitations were Human resource limitation, Limited technology resources, and Limited finance. The highest value of 5 was dominant in finance and technology limitations, while the value of 4 was chosen most frequently in human resource limitations.

No less than 50% of participants pointed that finance and human resources are an important limitation in achieving appropriate levels of digitalization.

Among most important external limitations, the internet, Lack of external funds, and Lack of experienced service providers were specified. The most frequent answer of highest limitations (5) was chosen for the internet limitation, while the lack of experienced service providers was inconclusive (3). High value of 4 was chosen as most frequently for Lack of external funds.

It is worth mentioning that no less than 50% of participants pointed that the internet was an important external limitation in digitalization.

6. DISCUSSION AND CONCLUSIONS

In our study, we showed that there are still significant barriers to the development of digitalization processes and Industry 4.0 concepts for companies operating in Poland. The respondents indicated the following most important barriers: limited financial and human resources, as well as the internet limitations. The respondents also identified moderately significant barriers: limited technology resources, lack of experienced providers, and lack of external funds. The research results undoubtedly prove the financial limitations of enterprises in Poland in the digitalization development. This should induce the authorities to implement a more intensive, comprehensive system of aid instruments and fiscal policy to support digitalization processes.

Conclusions from the research may also put forward specific demands for education policy in Poland, as evidenced by the lack of competences in the field of digitalization among employees. High availability of human resources for entrepreneurs in Poland, indicated in official reports, was rather questioned in our survey research.

The respondents also indicated the benefits of implementing digitalization and the Industry 4.0 concept. Much more than half of the respondents agree or completely agree with the fact that digitalization leads to the reduction or optimization of the resources used. This percentage is particularly high in medium and large enterprises and amounts to over 90% of the total responses. The respondents also indicated that digitalization leads to benefits for the company in three areas: financial, operational and, above all, in the strategic area. The indicated benefits of digitalization and the traits of Industry 4.0 for companies operating in Poland are confirmed by the results of studies by other authors: Boichuk, (2020), Ślusarczyk et al. (2020), Miśkiewicz et al. (2021) and Twaróg et al. (2021). These results justify formulating recommendations for company managers, but also those implementing economic and fiscal policy instruments, that the intensification of the implementation of digitalization and the Industry 4.0 concept in Poland cannot be treated only as a fashion, but it is a necessary action, bringing measurable financial and strategic benefits for corporate positions. It is important for the position held by Polish enterprises in the world, for increasing their competitiveness. According to the research results, in this dimension, there is much to be done in Poland.

Our research also indicates, more indirectly than directly, the following areas of increasing the intensity of digitalization implementation and the Industry 4.0 concept in Polish conditions:

- Developments of digitalization in the service and merchandising sector (including banking, insurance);
- Developed education system in exact sciences (including IT);
- Investments in energy sector (limitation of instability of renewable energy sources, reducing inflexibility of demand and generation, and boosting the ability to store energy);
- Emission reduction;
- Competitive advantage for SMEs companies, and access to resources (capital, know-how, competences).

In summary it can be noticed that an important area for the development of Industry 4.0 in Polish companies, especially from SME sector is increasing the awareness of the managerial staff and owners on this issue. Conducting promotional and training campaigns, at the level of education, seems to be crucial for the implementation of different solutions of Industry 4.0, and at the same time it sets new directions for research on the subject of Industry 4.0.

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'TO FAMILIARISE OR NOT TO FAMILIARISE' - INDUSTRY 4.0 IMPLEMENTATION IN SMEs IN HUNGARY

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Abstract

Industry 4.0 has penetrated through production and manufacturing industry into trade and services in the last couple of years. At another dimension it was first introduced in capital-strong large companies and infiltrated down to small- and medium-sized companies throughout the years. By now the use of Industry 4.0 is inevitable while the introduction and deployment is still capital intensive. The present research investigates the barriers and possibilities of Industry 4.0 among SMEs in Hungary and reveals the areas where the familiarity and satisfaction with I4.0 are different. The research uses quantitative analyses and concludes that despite the fact that SMEs needs to acquaint more with Industry 4.0 and be trained more, the different sectors apply I4.0 elements where it is the most applicable, 'middle-aged' SMEs (between 6 and 11) need more support while medium-sized 'aged' SMEs are the most prepared for Industry 4.0. The research reveals that cloud computing is the most used followed by IoT, and the

areas in which these elements are deployed are Business and Administration, Logistics and Customer Relationship Management.
Keywords: *Big data analytics, Cloud computing, Industry 4.0, IoT, SME, 3D printing*

1. INTRODUCTION

Globalisation of the economy in recent decades has led to an explosion of IT tools (Tóth & Kozma, 2017). In the early 2000s, under the impact of globalisation, the aim of the European Union (EU) was to make the EU 'the most competitive and dynamic knowledge-based economy in the world capable of sustainable economic growth with more and better jobs and greater social cohesion' (European Committee of the Regions, 2021).

Companies are increasingly interested in using new technologies to adapt to dynamically changing environmental conditions and to ensure their long-term competitiveness. At the same time, the fourth industrial revolution poses a huge challenge for manufacturing companies (Bleicher & Stanley, 2016). These challenges also affect companies' technological systems, organisational processes and management systems (Horváth & Szabó, 2019). Companies need to be prepared to successfully adapt to the shortening of the product life cycle and to meet changing consumer expectations.

The concept of Industry 4.0 (I4.0) was introduced by the German Federation for Industrial and Scientific Research in 2011 (Buhr, 2017), but the definition of the 4th Industrial Revolution is not uniform in the literature (Fettermann, Sá Cavalcante, de Almeida, & Tortorella, 2018). The term industry 4.0 is narrowly defined by Brettel et al. (2014): it can be considered I4.0 in which a firm creates a smart product using a production process and technological tools. Hermann et al. (2016) already interpret the concept more broadly. According to them, the concept includes a new technology and concept of value chain organisation, namely, a modularly structured smart factory where machines also communicate with each other in a cyber-physical system

(CPS), the CPS maps the physical world into the virtual world and decentralises operational decision-making with the help of autonomous machines. According to Schwab (2015), Industry 4.0 blurs the boundaries between the physical, digital, and biological spheres (Schwab, 2015). This will drive companies to continuously innovate by combining technological solutions, forcing top management to rethink the way they do business. In the definition by J. Nagy, Industry 4.0 can be described as a phenomenon that raises process transparency to a high level and integrates the corporate value chain and supply network through a set of technological tools and activities, thus taking customer value creation to a new level (Nagy, 2017).

A 2016 survey based on interviews with 2,000 professionals in 26 countries showed that the speed of technological progress depends on its acceptance and companies' willingness to invest (KPMG, 2016). The willingness of companies to invest can be boosted by falling prices for industrial equipment and software. Only 82% of surveyed companies considered their data analytics systems to be underdeveloped, and more than half of the organisations surveyed lack the knowledge and skills to process data and exploit information to gain a competitive advantage (PwC, 2016). Although more than two-thirds of the business leaders surveyed believe that Industry 4.0 is very important for their company's competitiveness, only 46 percent of them perform data analysis consciously (Nick, 2017). The use of digital technologies in manufacturing processes is also referred to as 'smart manufacturing', 'industrial internet' and 'integrated industry' (Hofmann & Rüsch, 2017)

The authors agree that Industry 4.0 represents a technological revolution in industrial production.

In this context, production processes have been networked and decision-capable devices that can communicate with each other have conquered production processes. The main pillars of Industry 4.0 are Machine-to-Machine (M2M), Artificial Intelligence (AI), Robotics, Quantum Computing, Internet of Things (IoT), Internet of Services (IoS), 5G, Cloud Computing, Big Data, Edge Computing (Hammond, 2017; Nagy, Oláh, Erdei, Máté, & Popp, 2018; Oláh, Karmazin, Pető, & Popp, 2018).

Digitalisation technologies can create new value by breaking down physical barriers: knowledge and extensive data collection through the internet can extend products and services that previously existed only in physical space. Moreover, the digitisation of processes makes it easier to optimise them, leading to more efficient and competitive production.

Based on the definition by Smit et al. (2016), *"Industry 4.0 describes the organisation of production processes based on technology and devices autonomously communicating with each other along the value chain: a model of the 'smart' factory of the future where computer-driven systems monitor physical processes, create a virtual copy of the physical world and make decentralised decisions based on self-organisation mechanisms"* (Smit, Kreutzer, Moeller, & Carlberg, 2016).

Industry 4.0 is present at all levels up the management hierarchy (Nagy, Tasner, & Kovács, 2021), from process development to strategic decisions by top management. As a result, an increasingly wide range of companies are affected by I4.0.

However, companies of different sizes do not operate in the economy on the same terms. Large multinational companies have a greater potential to introduce new technologies and carry out research projects compared to SMEs because they have a greater pool of resources and capacity (Kennedy & Hyland, 2003). However, SMEs are in a more difficult position and less prepared for new technologies and consumer expectations (Smit, Kreutzer, Moeller, & Carlberg, 2016). At the same time, Mishra (2016) found that SMEs' production systems are more flexible, which is an advantage in a turbulent changing environment and increasingly intense competition (Mishra, 2016). Mittal et al. (2018) compared the capabilities of large firms and SMEs in Industry 4.0 along 17 dimensions (Mittal, Khan Ahmad, Romero, & Wuest, 2018). These are financial resources, use of advanced manufacturing technologies, software umbrella, research and development, nature of product specialisation, attention to standards, organisational culture/managerial flexibility, corporate strategy, decision making, organisational structure, human resource commitment, exposure to human resource development, industry knowledge and experience, alliances with universities or research institutes, key activities, dependence on collaborative networks, and customers and suppliers. Their results show that SMEs have weaker networks, fewer suppliers and are more dependent on them than multinationals.

This study aims to reveal how well SMEs in Hungary are familiar with the term Industry 4.0, which elements of I4.0 are used by the SMEs, whether SMEs use the different elements of I4.0 and what is their level of satisfaction with the introduced I4.0 elements. The research was carried out within the framework of the Visegrad Fund project 'Possibilities and barriers for Industry 4.0 implementation in SMEs in V4 countries and Serbia' during the period September -December 2021.

The paper formulates three research questions, namely:

RQ1: What is the level of familiarity of Industry 4.0 among SMEs and do the demographic features (age, size and the economic sector in which an SME operates) influence SMEs' familiarity with Industry 4.0?

RQ2: Along which demographic features are the familiarity and satisfaction of SMEs with Industry 4.0 elements significantly different?

RQ3: Which fields of business are most supported by Industry 4.0 technologies among SMEs and is it influenced by the main economic sector an SME operates in?

The paper is organised as follows: after the introduction of the terms, it presents research methodology and data collection methods, then the next section gives the demographic profile of the sample and presents participating SMEs' responses. The results section also discusses the findings and implications and the conclusions on the research questions are made in the conclusion section.

2. METHODOLOGY AND DATA

The research was conducted under the project “Possibilities and barriers for Industry 4.0 implementation in SMEs in V4 countries and Serbia”. A self-administered questionnaire was designed by the participating countries to collect data from SMEs in each V4 country and Serbia. A pilot of the survey was carried out to confirm the comprehensibility of the questions. The quantitative research used both the online and paper version of questionnaire. Google form was used for the administration of the online questionnaire. The questionnaire was translated into the language of the participating countries so Hungarian SMEs were invited to spends 10-15 minutes answering the questions in Hungarian. The questionnaire was disseminated among the respective SMEs in September/October 2021. Anonymity was ensured, no personal information was required. The data gathered 112 responses providing a large sample, however, due to the method of data collection the dataset does not give a representative sample.
This paper focuses on the questions linked to Industry 4.0 – including familiarity and satisfaction with Industry 4.0 – and the responses from the Hungarian SMEs are analysed. Quantitative analysis was conducted to reveal SMEs’ familiarity and satisfaction with I4.0 using the statistical programme SPSS version 25. Descriptive analysis was applied to give a general view of SMEs’ approach and to reveal where I4.0 and its elements are used by SMEs in Hungary, then CHI^2 tests and ANOVA analyses were used to reveal whether the different sized and aged companies operating in different economic sectors have different knowledge of I4.0.

3. RESULTS

3.1. Demographic profile

A total number of 112 questionnaires were completed by Hungarian SMEs each of which could be analysed. Due to the nature of data collection and also in terms of diversity the sample is not representative despite its size, implying that the results are relevant for the SMEs in the survey and generalisation cannot be drawn. Apart from the demography of the SMEs the personal characteristics of the responding business professionals are also presented since the experience and the position of the business professional justify that the findings on SMEs reflect the situation among the SMEs in Hungary.

Business professionals responding the survey have considerable work experience almost half of the professionals surveyed have more than 20 years of work experience (49.11%), almost a third have more than 10 years and more than 10% of the sample have 6-10 years of work experience. Close to half of the respondents (47.3%) are between 46 and 60 years, and the average age of the business experts is 46.4 years. In terms of position, three-quarters of the respondents are company owners, 16,1% are middle managers and 4,4% managers, which means that a mere 4.5% of the respondents are employees.

The demographic composition of the sampled companies was also asked, namely, the age, size, area of business activity, business focus, and the dominant sector the company operates. Two-thirds of the enterprises surveyed are micro enterprises (66.1%), a quarter of them are small enterprises (26.8%) while 6.3% are medium-sized enterprises. Figure 1 shows that a third of the enterprises (33.9%) have been in business for 11-20 years, 25%-25% of them have been running for more than 21 years and for 6-10 years each, 8.9% of them have been operating for 3-5 years and only 7.1% of them are fresh businesses with operation up to 2 years.

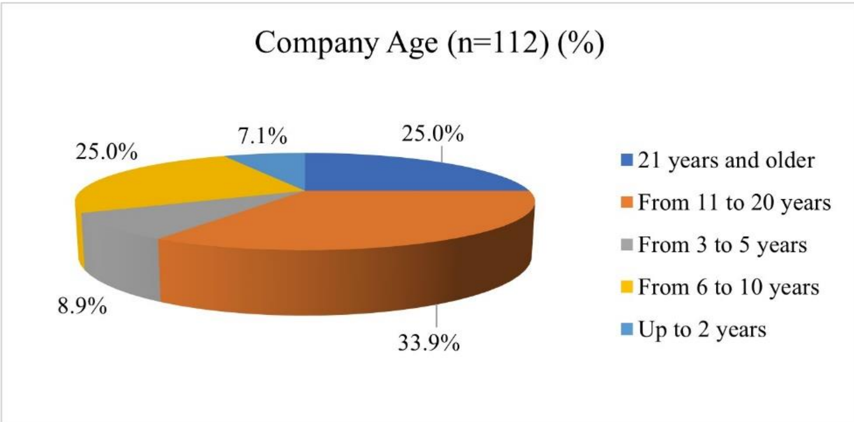

Figure 1. Distribution of company age
Source: Author's

More than half of the enterprises in the sample operate in the services sector (55%), nearly a third in the trade sector (32.1%) and a tenth in the production sector.

The area of business distribution is as follows: more than 20% of the enterprises surveyed are in Wholesale and retail trade, 16.96% in Construction and developers, 13.39% in Information and communication, 6.25% in Manufacturing and less than 4% in Finance and insurance and Industry including energy.

Almost two-thirds (60.71%) of the enterprises in the sample are doing business exclusively on the domestic market, 21.43% of them do business mostly on the domestic market and 13.39% operate equally on the domestic and foreign market. Due to the nature of the sample, the share of multinational companies is below 2%.

3.2. Industry 4.0

The following section discusses in detail how familiar the responding SMEs are with the term Industry 4.0 (I4.0), which elements the company apply and how satisfied with these elements the businesses are. Furthermore, discussion is made on the area where SMEs use I4.0 elements and whether SMEs with different age, size and economic sector have different usage and approach to I4.0.

3.2.1. Familiarity with Industry 4.0

Figure 2 shows that 59.82% of the responding SMEs in Hungary are not familiar with the term I4.0, only 40.18% marked 'yes' for the question. Even over half of the SMEs marked 'No' for the question some elements of I4.0 is known and used in these SMEs (presented later).

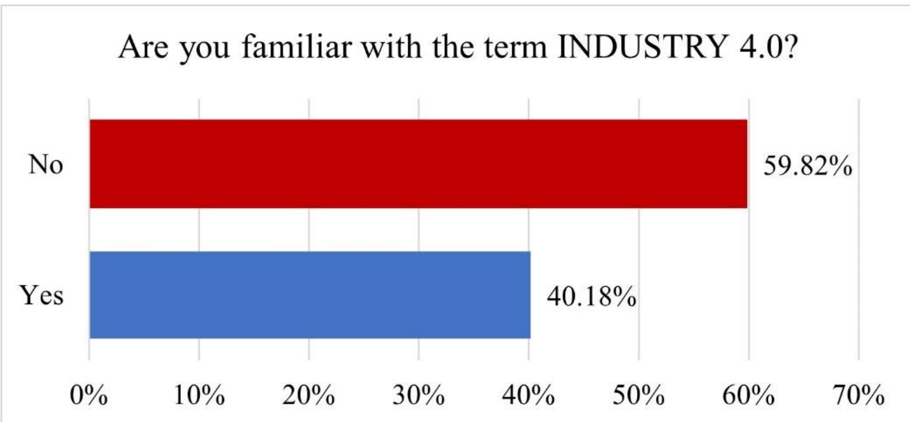

Figure 2. Familiarity with the term Industry 4.0 among Hungarian SMEs
Source: Author's

Taking the economic sectors into consideration – production, trade or services – the SMEs doing business in the different sectors have similar knowledge/familiarity about I4.0 (CHI^2=0.81, p=0.667), although it would be expected that SMEs operating in the Production sector would be more familiar with the term since I4.0 originates from manufacturing and production. In addition, half of the responding SMEs were familiar with the term in the production sector while only

36.1% and 40.3% in the Trade and Services sectors, respectively. It implies that the production sector is the most familiar with the term while trading sector is the least familiar with it.
Different-sized SMEs have different familiarity with the term I4.0 (CHI^2=6.369, p=0.041) even if it is a weak relationship (Cramer's V=0.238). Half of the small-sized SMEs (number of employees between 10 and 49) in the survey knew the term (55.2%), while one-third of micro-SMEs (number of employees up to 9) and two-thirds of medium-sized SMEs (number of employees between 50 and 249) were familiar with the term. It must be noted, however, that the proportion of medium-sized SMEs is relatively low in the sample (5.36%).
The age of the company shows a weak relationship with the familiarity of the term Industry 4.0 (Cramer's V=0.173), and the relationship's significance stands at the commonly accepted 5% (p=0.501). Therefore, further research is needed to explore whether the maturity of an SME would bring better knowledge of the term.

3.2.2. Training required in Industry 4.0

SMEs where the familiarity of the term I4.0 was lacking were asked whether they would like to have further training. The majority of SMEs do not wish to get further training, in each sector less than 40% of the respondents would like to have additional training on I4.0, which might mean challenges to SMEs provided they wish to develop digitally and technologically in the future Figure 3. No significant relationship was found (CHI^2=0.397, p=0.82).

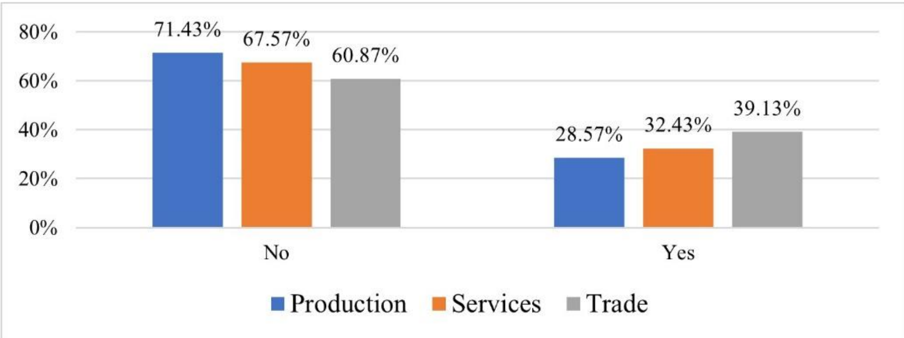

Figure 3. Proportion of respondents for the further training option for Industry 4.0 by economic sector
Source: Author's

Figure 4 shows that similar tendency could be traced when considering the size of an SME (CHI^2=3.108, p=0.211). Over half of the participating small-sized SMEs (employees from 10 to 49) voted for further training (53.85%) while a mere 28.85% of micro-SMEs (up to 9 employees) would like to have additional training despite the fact, that familiarity with I4.0 was the lowest among them.

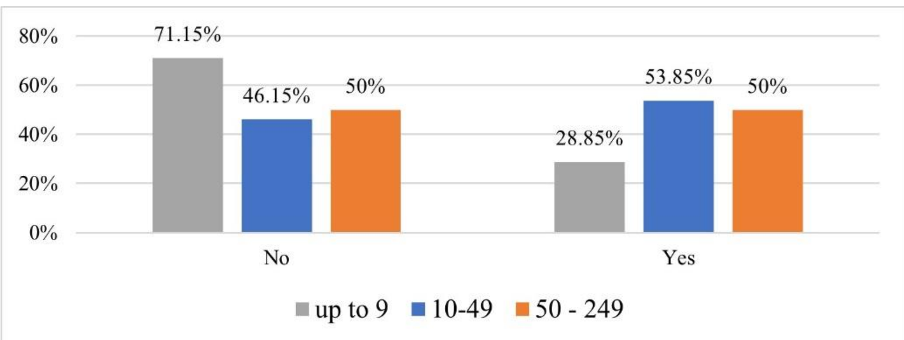

Figure 4. Proportion of respondents for the further training option for Industry 4.0 by the size of the company
Source: Author's

Similar tendency can be traced when taking company age into consideration (Figure 5).

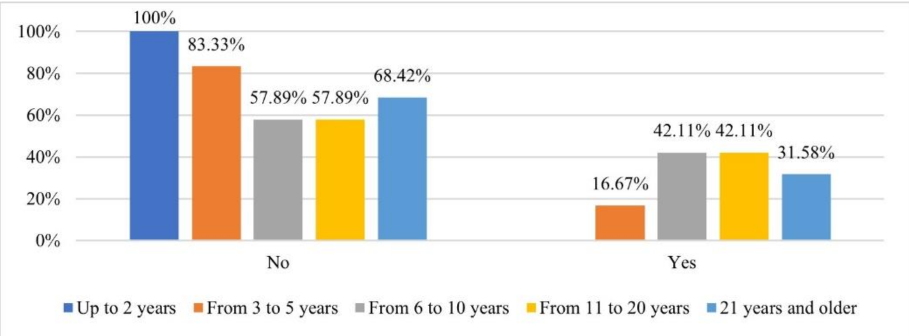

Figure 5. Proportion of respondents for the further training option for Industry 4.0 by company age
Source: Author's

The proportion of SMEs where further training about I4.0 is required is not significantly different along the age of the companies (CHI^2=3.709, p=0.295), although higher interest could have been expected from younger SMEs (up to 5 years) since the usage and familiarity with I4.0 is lower among them. In comparison, the youngest SMEs do not wish to have further training, while 42.11% of SMEs older than 6 and younger than 20 would participate in further training.

3.2.3. Usage of Industry 4.0 elements

SMEs were also questioned about their familiarity with Industry 4.0 elements, namely whether they have heard about them and whether they use these elements in their regular business processes. The elements included were the following: cloud computing services, 3D printing and robotics, Virtual Reality (VR), Artificial Intelligence (AI), Internet of Things (IoT), Supply chain management, Augmented Reality (AR) and Big Data analysis.

Figure 6 shows that even around 60% of the responding SMEs are not familiar with the term 56.25% of them have heard about Cloud computing and use it either occasionally or in everyday business operations. Despite the fact the 40% of the SMEs are familiar with the term I4.0, the proportion of SMEs using its different elements is 30% or even less apart from cloud computing services. The least used I4.0 element is Artificial Intelligence (23.21%), one quarter of SMEs in Hungary uses 3D printing, supply chain management and Virtual Reality, while augmented reality and Big Data analysis are used in 26.79% and 27.68% respectively.

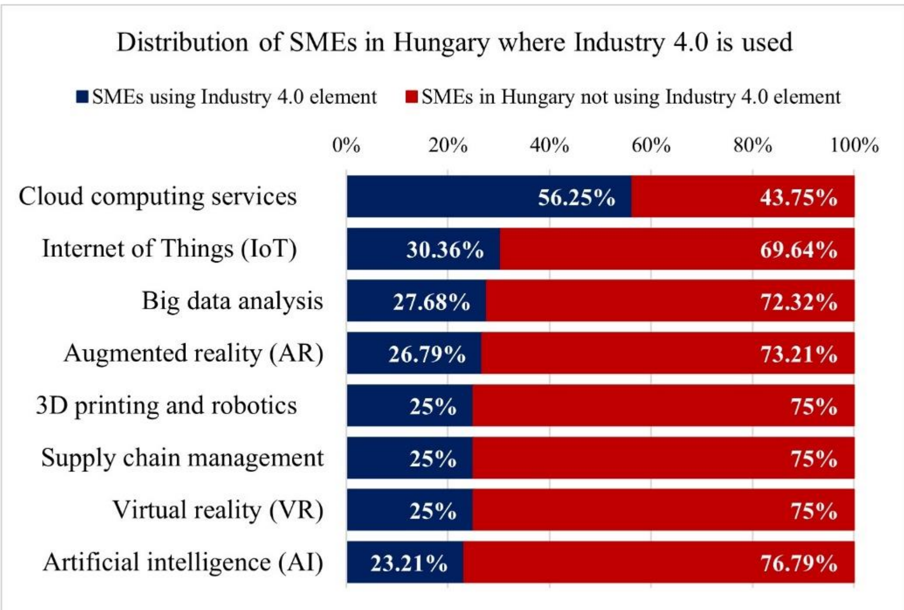

Figure 6. Distribution of SMEs in Hungary using and not using Industry 4.0 elements
Source: Author's

SMEs apply I4.0 elements mostly in the area of customer relationship (58.04%), management and administration (49.11%) and logistics

(27.68%) while it is the most rarely implemented in the area of Waste reduction (2.68%), Environmental protection (5.36%) and in personalisation of products (11.61%). Figure 7 presents that even within sectors the area where I4.0 is used is customer relationship, and management and administration and logistics.

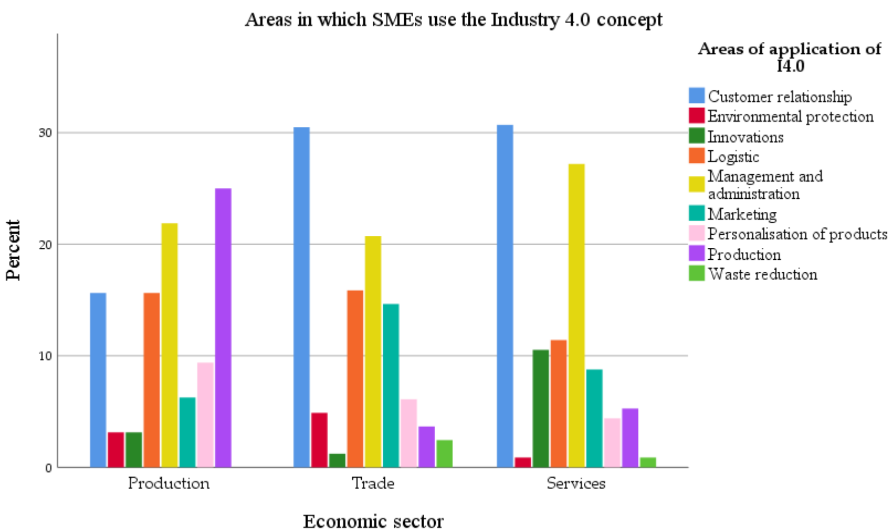

Figure 7. Fields of business SMEs implement I4.0
Source: Author's

The economic sectors make a difference in which areas are developed with I4.0 technologies (CHI^2=48.809, p=0,000). In the production sector production itself is the mostly backed by I4.0 technologies (25%), while it is not really used in the trade and service sector (6.1% and 4.39% respectively. Innovations are backed by I4.0 technologies rather in the service sector (10.53%) compared to the other sectors (3.13% in production sector and 1.22% in trade sector) while marketing is rather supported by I4.0 in the trade sector (14.63%) compared to the other two sectors (6.25% in the production sector and 8.77% in the services sector). Personalisation of products is backed by

I4.0 rather in the production sector, however only 9.38% of SMEs observed use it. None of the listed Industry 4.0 technologies are not used by more than 30% of the observed SMEs in the different sectors, which implies that SMEs need further digitalisation and I4.0 technological developments in the future to improve their production, innovations or environmental protection activities and waste reduction.

3.2.4. Familiarity with Industry 4.0 elements

The usage of Industry 4.0 elements was surveyed on a Likert scale ranging from 1 – 'never heard about it' to 5 – 'have heard and use it in everyday business operations'. Further response options were 2 – 'have heard but never used', 3 – 'have heard and do plan to use it' and 4 – 'have heard and use it occasionally'.
Table 1 presents that SMEs are familiar with cloud computing services, half of the SMEs have heard about it and use it in their business processes and the majority of the responding SMEs use it in their everyday business operations.

Table 1. Familiarity with Industry 4.0 components among SMEs in Hungary (n=112)

Familiarity with I4.0 components	Mean	Median	Mode	SD	IQR
Cloud computing services	3.44	4	5	1.419	3
3D printing and robotics	2.39	2	2	1.102	1
Virtual reality (VR)	2.34	2	2	1.087	1
Artificial intelligence (AI)	2.31	2	2	1.163	1
Internet of Things (IoT)	2.23	2	1	1.414	2
Supply chain management	2.11	2	1	1.157	2
Augmented reality (AR)	2.06	2	2	1.051	1
Big data analysis	2.05	2	1	1.214	2

Source: Author's

However, the opposite can be stated about the other elements since the majority have heard but never used the specific element – 3D printing and robotics, VR, AI, AR –, or have never heard about them – IoT, Big Data analysis and Supply Chain Management. Half of the SMEs in the research either never heard the element or have heard but never used it. Figure 8 displays the sentiment analysis of responses, and it shows that SMEs using 3D printing rather use it occasionally, while when it is used, AI is rather used in everyday business. In summary, however, the knowledge of these elements of I4.0 is relatively low among the responding SMEs in Hungary.

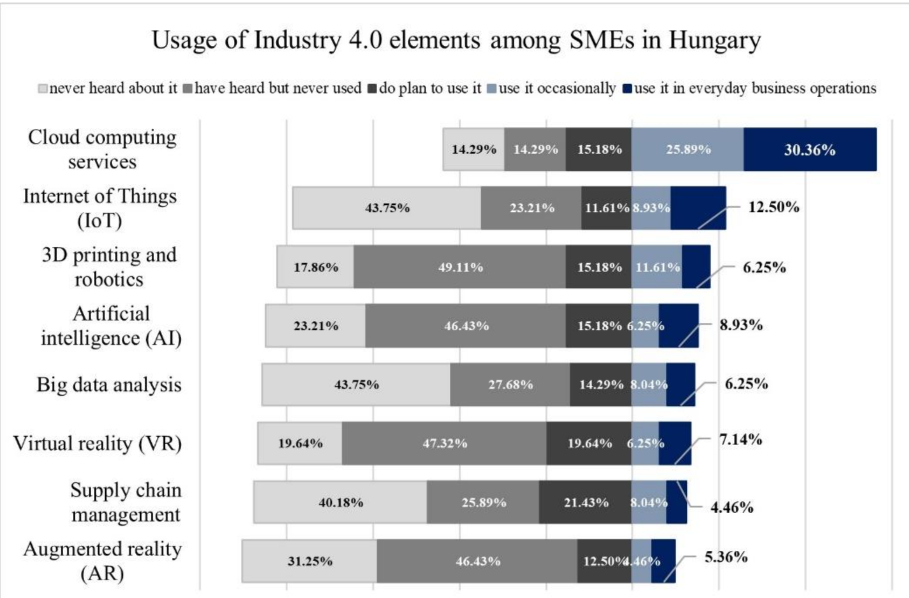

Figure 8. Distribution of responses about the knowledge of Industry 4.0 elements among SMEs in Hungary
Source: Author's

On analysing SMEs by size, age and main economic sector, no significant differences were detected in the familiarity with I4.0 elements in the different sectors and among the SMEs with different age. However, the size of SMEs seemed to be a good separating factor (see Table 2). Significant differences were found in case of could computing services, Big data analysis, IoT and Supply Chain Management. Familiarity grew by size and for the elements 'Big data analysis' and 'Supply Chain Management' the significant difference was seen between micro and small-sized SMEs. For could computing services the significant difference was found between micro-SMEs and medium-sized SMEs. Based on the previous findings medium-sized SMEs are more prepared for Industry 4.0 technologies and are more familiar with them.

Table 2. Difference in familiarity with I4.0 elements by size of SMEs

ANOVA	**F**	**Sig.**	**Levene Statistic for homogeneity of variances**	**Sig.**
Cloud computing services	3.657	***0.029***	1.681	*0.191*
Big data analysis	4.623	***0.012***	1.856	*0.161*
3D printing and robotics	0.692	*0.503*	2.529	*0.084*
IoT	3.232	***0.043***	0.724	*0.487*
VR	2.080	*0.130*	5.201	***0.007***
AR	2.900	*0.059*	3.789	***0.026***
Supply Chain Management	5.876	***0.004***	2.430	*0.093*
AI	2.803	*0.065*	4.131	***0.019***

Source: Author's

3.2.5. Satisfaction with Industry 4.0

SMEs that use I4.0 elements occasionally or in their everyday business operations were asked to rate their satisfaction with the specific elements. The responses ranged on a Likert scale from 1 – "not satisfied at all" to 5 – "completely satisfied". As written above even those SMEs who are not familiar with the term apply I4.0 elements in their business operations. Table 3 presents that majority of SMEs who apply I4.0 technologies are satisfied or completely satisfied with the technology, the Mean, Median and Mode of the responses are all in the satisfaction range. However, SMEs that are not satisfied or neutral about the technology must be further analysed. The proportion of these SMEs ranges between 22.22% (cloud computing services) and 58% (Big Data analysis). Interestingly, cloud computing services were the most known among the SMEs and Big Data analysis was the least familiar to the SMEs. It assumes that Big Data analysis is not developed to such user friendliness as SMEs would expect, or employees are not adequately trained and skilled to use Big Data analysis. It also assumes that cloud computing services have become regular business applications among SMEs and technology can work in good balance and up to the requirements with the employees.

Table 3. Satisfaction with Industry 4.0 among SMEs in Hungary

Satisfaction with I4.0 elements - responses from those who use I4.0 occasionally or in everyday business operation	**n**	**Mean**	**Median**	**Mode**	**SD**	**IQR**
Cloud computing services	63	4.06	4	5	1.061	1
Internet of Things (IoT)	34	3.65	4	4	1.252	2
3D printing and robotics	28	3.54	4	4	1.290	1.75
Artificial intelligence (AI)	26	3.46	4	4	1.392	2.25
Big data analysis	31	3.29	3	3	1.442	2
Supply chain management	28	3.29	3.5	4	1.301	1.75
Virtual reality (VR)	28	3.14	3	4	1.239	2
Augmented reality (AR)	30	3.13	3	4	1.306	2

In order to give a better picture of the satisfaction with I4.0 element, the responses were recoded to “not satisfied”, “neutral” and “satisfied”. Figure 9 gives the sentiment analysis of the recoded responses. 77.78% of the responding SMEs are satisfied with cloud computing services, while 61.76% and 60.71% of them are satisfied with IoT and 3D printing and robotics. 57.69% of them are satisfied with AI and half the SMEs are satisfied with Supply chain management. However, the non-satisfaction and neutrality reached above 50% for Big Data analysis, VR and AR. In order to reveal the causes further research is needed.

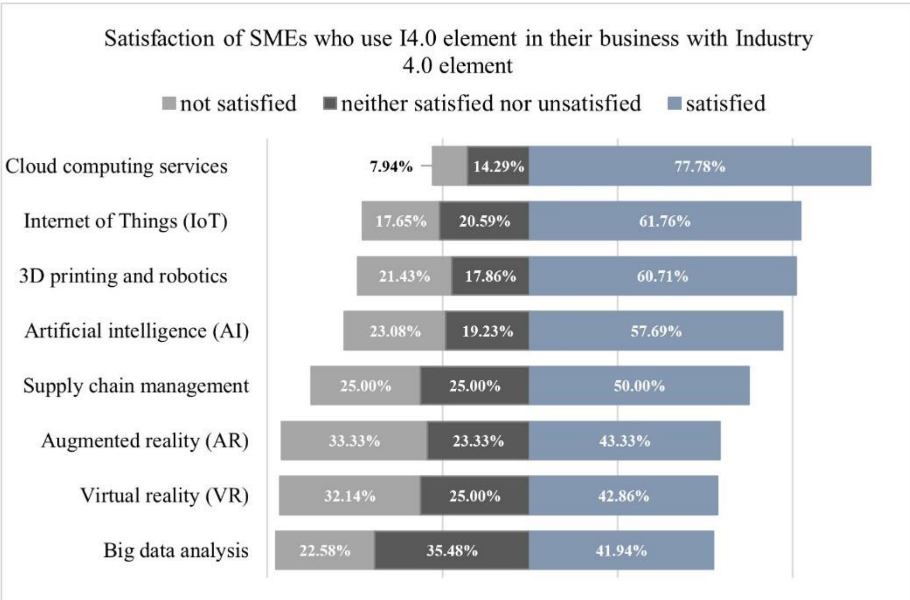

Figure 9. Distribution of responses about the satisfaction of Industry 4.0 elements among SMEs in Hungary
Source: Author's

Among the responding SMEs which were familiar with the I4.0 elements no significant differences could be found when satisfaction was checked against the size of the company. SEMs which are familiar and apply I4.0, their satisfaction level is similar. However, the age of the SME showed a significant difference in satisfaction in some elements (Table 4).
Significant differences were detected for big data analysis, AI, VR and supply chain management. For the element VR the significant difference is between the SMEs up to 5 years and the ones between 6 and 10 years old. Interestingly the SMEs between 6 and 10 were less satisfied with the implemented VR. For big data analysis again the

SMEs in the age between 6 and 10 differed significantly from the others but in this case the significant difference was against SMEs older than 10 years. For AI the same group differed significantly from the SMES between 11 and 20 while in case of supply chain management SMEs between 6 and 10 differed from the younger ones and the ones between 11 and 20.

Table 4. Difference in satisfaction with I4.0 elements by age of SMEs

ANOVA	**F**	**Sig.**	**Levene Statistic for homogeneity of variances**	**Sig.**
Cloud computing services	0.972	*0.412*	3.268	***0.027***
Big data analysis	4.844	***0.008***	0.438	*0.727*
3D printing and robotics	0.945	*0.435*	2.884	*0.057*
IoT	0.368	*0.777*	3.082	***0.042***
VR	3.236	***0.040***	1.188	*0.335*
AR	2.285	*0.102*	1.663	*0.199*
Supply Chain Management	4.995	***0.008***	1.465	*0.249*
AI	5.370	***0.006***	1.438	0.259

The results indicate that after the first satisfaction and euphoria, a downswing comes in the life of SMEs (between 6 and 10) then with time the use of I4.0 elements becomes a common practice and satisfaction grows again. The satisfaction with I4.0 elements did not differ significantly by the economic sectors.

4. CONCLUSION

The research conducted among SMEs in Hungary within the framework of the project ‘Possibilities and barriers for Industry 4.0 implementation in SMEs in V4 countries and Serbia’ revealed valuable results for consideration. As part of the research the familiarity and satisfaction with I4.0 was evaluated. Mostly business owners and managers responded to the questions. Since most of the business professionals participating had long-term work experience, were mostly middle-aged or older, are business owners or senior managers the responses for the SMEs could be considered reliable. As respondents are higher in the hierarchy in the organisational structure of a company, they have more insight in the company's strategic operations, have a better view of the company operations and are in a business decision making position. These business experts make decisions which I4.0 elements to introduce and implement at the enterprise and they see how capable the enterprise is to improve on performance, productivity and profitability by I4.0 deployment. The conducted research has some limitations since the proportion of medium-sized companies was relatively low, the sample size needs to be increased for further research, however, the proportion of owners and managers who responded provided a good sample for evaluation.

Three research questions were posed and the findings in terms of the research questions are presented next.

RQ1: What is the level of familiarity with Industry 4.0 among SMEs and do the demographic features (age, size and the economic sector in which an SME operates) influence SMEs' familiarity with Industry 4.0?

The research found that both the familiarity of the term "Industry 4.0" and the elements of Industry 4.0 except cloud computing services is very low. It implies that extra information and the dissemination of knowledge is of key importance, SMEs need to get familiar with the term and the elements before actually introducing it into their practices. On the other hand, it was found that larger SMEs are more familiar with the term, the proportion grew from around 30% to around two thirds of SMEs of different size. It must be noted, however, that the proportion of medium-sized SMEs is relatively low in the sample.

Meanwhile, the sector SMEs operate in and the age of the enterprise did not show significant differences in familiarity with I4.0. Regarding the sector, even if it is insignificant, the production sector seems to be the most familiar with the term while trading sector is the least familiar with it. The result reflects that I4.0 was first introduced in the manufacturing industry and later it penetrated into the trading and services sector. Due to the 5% significance in case of company age, further research is needed to explore whether the maturity of an SME would bring better knowledge of the term. Even if SME representatives – owners and managers – lack familiarity with I4.0 and majority of them do not use it, no further training was required by most of them, which might mean challenges to SMEs provided they wish to develop digitally and technologically in the future. As stated by Smit et.al. (2016) SMEs are in a more difficult position and less prepared for new technologies but at the same time as argued by Mishra (2016) SMEs are more flexible in terms of production systems that can be advantageous in fierce competition. Again, dissemination and more information are required to make the term and benefits clear to these SMEs. The use of I4.0 elements like cloud computing or IoT depend on the digitalisation level of the company. The digitalisation of SMEs as part of the research project is evaluated separately. Similar behaviour was found in the different sectors, for size and for age as well. It must be noted that the highest proportion of SMEs where further training was required were companies between 6 and 20 years old, which implies that after the motivation and the first successes of I4.0 some disillusionment or disappointment emerge which the company can overcome with further digitalisation and training. The youngest SMEs do not wish to have further training.

RQ2: Along which demographic features are the familiarity and satisfaction of SMEs with Industry 4.0 elements significantly different?

Despite the fact that a large proportion of the responding SMEs are not familiar with I4.0, some elements are still used and used with satisfaction. Upon evaluation the familiarity and satisfaction of SMEs with I4.0 elements cloud computing proved to be the most used element. Over 50% of the responding SMEs use cloud computing services while the second most used element – IoT – is used by around 30%. All the other I4.0 elements are used by less than 30% of the participating SMEs. It indicates that even if the I4.0 elements are available, these are not introduced and deployed in companies.

Interestingly, cloud computing services were the most known among the SMEs and Big Data analysis was the least familiar to them. In accordance with the findings of PWC (2016) stating that most companies don't yet have mature data analytics capabilities, the findings show that Big Data analysis is wither not developed to such user friendliness as SMEs would expect, or employees are not adequately trained and skilled to use Big Data analysis. It also assumes that cloud computing services have become regular business applications among SMEs and technology can work in good balance and up to the requirements with the employees.

SMEs are familiar with cloud computing services; half of the SMEs have heard about it and use it in their business processes and the majority of the responding SMEs use it in their everyday business operations. However, the opposite can be stated about the other elements since the majority have heard but never used the specific element – 3D printing and robotics, VR, AI, AR –, or have never heard about them – IoT, Big Data analysis and Supply Chain Management. Half of the SMEs in the research either never heard the element or have heard but never used it.

Grouping the SMEs by age and the main economic sector, similar usage was found, no significant difference was detected. However, the size of SMEs seemed to be a good separating factor, because significant differences were found for four elements, namely, could computing services, Big data analysis, IoT and Supply Chain Management. Familiarity grew by size and for the elements 'Big data analysis' and 'Supply Chain Management' the significant difference was seen between micro and small-sized SMEs. As argued by Kennedy et al. (2003) due to capital soundness larger companies have a greater potential to introduce new technologies. For could computing services the significant difference was found between micro-SMEs and medium-sized SMEs. Based on the previous findings medium-sized SMEs are more prepared for Industry 4.0 technologies and are more familiar with them.

Most of the participating SMEs who apply I4.0 technologies are satisfied or completely satisfied with the technology. However, the non-satisfaction and neutrality reached above 50% for Big Data analysis, VR and AR. Regarding training, SMEs that are not satisfied or neutral about the technology must be targeted with further training and even further research is to be conducted to reveal the reasons why SMEs are not satisfied with the specific element.

When satisfaction was checked against company size and the domination sector, no significant differences could be found. However, the age of the SME showed a significant difference in satisfaction in some elements. Companies between 6 and 10 shows less satisfaction (they showed the highest interest in training with companies between 11 and 20). It assumes that in the life cycle of a company there also comes a 'trough of disillusionment', a dissatisfaction period after the 'technology trigger' and the 'peaked inflated expectations' phases as defined in the Hype cycle developed by Gartner (2018) for innovative technologies. With time the use of I4.0 elements becomes a common practice and satisfaction grows again reaching the 'plateau of productivity' through the 'slope of enlightenment'.

RQ3: Which fields of business are most supported by Industry 4.0 technologies among SMES and is it influenced by the main economic sector an SME operates in?

Three main areas of business have been found – Customer Relationship, Management and Administration and Logistics – that are most supported by I4.0 technologies, which is in line with the findings by PWC (2016). Economic sectors' readiness for I4.0 is different significantly and the fields SMEs in different sectors apply I4.0 technologies differ significantly. As expected, the production sector uses I4.0 for production the most, while the service sector invested the most in customer relationship, but management and administration is equipped with I4.0 technologies similarly. In the trade sector customer relationship is the outstanding field of business where I4.0 is applied. Not outstanding but significant that the service sector puts an emphasis in equipping innovations with I4.0 technologies, however environmental protection and waste reduction are out of SMEs' focus. Personalisation of products with I4.0 technologies is typical in the production sector while marketing backed by I4.0 is typical in the trade sector.

None of the listed Industry 4.0 technologies are not used by more than 30% of the observed SMEs in the different sectors, which implies that SMEs need further digitalisation and I4.0 technological developments in the future to improve their production, innovations or environmental protection activities and waste reduction.

SMEs tend to select, as expected, the elements relevant to their business profile, however, the level of digitalisation as well as the company age, size and sector all influence the use and application of I4.0 elements in the specific fields.

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INDUSTRY 4.0 TECHNOLOGIES: RESULTS OF AN INTERNATIONAL STUDY IN SMEs

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Abstract

Industry 4.0 has been considered a new industrial stage that provides innovative ways of conducting companies based on advanced digital technologies. In larger companies, digitization initiatives are usually incorporated into the primary corporate strategy, while Small-and Medium-sized Enterprises (SMEs) often have problems implementing the Industry 4.0 concept. However, there is a lack of understanding to what extent SMEs implement these technologies. Therefore, this paper aims to determine the level of use of the Industry 4.0 related technologies in SMEs in six European countries. The features and functionalities of Industry 4.0 related technologies are discussed in detail. The best-ranked country was selected by a multi-criteria decision-making (MCDM) approach based on integrating the Entropy-TOPSIS (Technique for Order of reference by Similarity to Ideal Solution) methodology. The results of this study have significant implications for both scientific research and management practice in considered countries.
Keywords: *Industry 4.0, SMEs, Industry 4.0 related technologies*

1. INTRODUCTION

Today's industry faces a new generation of fully digitalized factories, which is why the industrial surroundings have changed radically in recent years. The main reason for this is the introduction of technologies and concepts based on the fourth industrial revolution, better known as Industry 4.0 (Sendler, 2013; Matt & Rauch, 2020; Milošević et al., 2021). This concept was initially introduced in Germany in 2011 (Lu, 2017; Masood & Sonntag, 2020). Industry 4.0 concept is based on a system in which all the processes are integrated, and information is shared in real-time. This is achieved by incorporating human actors, physical objects, intelligent machines, and production lines and processes (Hozdić, 2015; Masood & Sonntag, 2020).

Industry 4.0 implies complete digitalization of all production processes and applying the new technologies when creating an idea about a product, product engineering, production organization, production realization, process control and provision of industrial services (Ibarra et al., 2018; Bai et al., 2020). Technologies such as the Internet of Things, robotics, Cloud Computing, cyber-physical systems and Big Data are essential in applying the concept of Industry 4.0.

Industry 4.0 is equally important for everyone in the supply chain, from large international companies to small suppliers. Today, digitalization completely changes how companies produce and develop, increasing productivity and thus competitiveness in the global market. Big companies worldwide have rapidly embraced the challenges of Industry 4.0 and are currently working intensively on the introduction of new digital technologies. SMEs, on the other hand, face a number of challenges. SMEs often have a problem with a lack of financial and human resources to invest in a detailed analysis of the potential and risks for introducing Industry 4.0. However, today many market economies base their growth and development on small and medium enterprises and entrepreneurship, which is the most efficient segment of the economy and makes the greatest contribution to employment, GDP and turnover (Masood & Sonntag, 2020).

That was the main motive to conduct research examining the requirements, opportunities, and challenges that Industry 4.0 has in SMEs, thus paving the way for the digital transformation of traditional SMEs into smart factories. Therefore, this paper aims to investigate the level of implementation of Industry 4.0 related technologies in six European countries in SMEs. In order to rank countries (Hungary,

Poland and Slovakia, Czech Republic, Republic of Serbia and Bulgaria) the TOPSIS method was employed. Furthermore, the Entropy method was employed to effectively avoid the effects of human subjective opinion for calculating the weight of all the criteria in TOPSIS calculation.
The obtained results can be useful for decision-makers in SMEs. Enterprises that use advanced digital technology can now collect, analyze, and convert data into understandable reports that provide management, production, and supply chains with valuable insights (Buyukozkan & Gocer, 2019). The best-ranked country can serve as a benchmarking country to other analyzed regions.
The remainder of this paper is set out as follows. Section 2 supplies some basic information on Industry 4.0 technologies.
In Section 3, the methodology of the multi-criteria decision-making was presented. In Section 4, the results of the application of integrated Entropy-TOPSIS methodology for country selection were given. The study concludes and provides recommendations for further research in Section 5.

2. LITERATURE REVIEW

Traditionally, SMEs are often exposed to various survival challenges due to limited resources to which they have access and often a low level of support. In SMEs, limited resources can lead to limited development opportunities and innovations, which in the opinion of many authors, is key to the success of any company. Therefore, cooperation plays an increasingly important role in innovation-related activities (Ahuja, 2000; Casals, 2011; Gronum, 2012; Agostini & Nosella, 2020).
Existing scientific literature shows that SMEs and large companies are fundamentally different in terms of size, process, and access to resources. For that reason, SMEs require different strategies in relation to large companies to succeed implemented Industry 4.0 (Müller et al., 2017). How do SMEs have fewer resources have a lower intensity of

research and development activities and face more uncertainty and obstacles to innovation.

2.1. Industry 4.0 technologies

The fourth industrial revolution aims to promote agility of production processes to increase efficiency and effectiveness in a particular industry (Lu, 2017). Industry 4.0 is based on information and communication technologies (ICT). Some of the characteristic Industry 4.0 related technologies analyzed in this paper, such as Cloud Computing, Big Data Analysis, 3D printing and robotics, the Internet of Things, Virtual Reality, Augmented Reality, Supply Chain Management, Artificial Intelligence (Gerbert et al., 2015). Furthermore, the utilization of digital technologies can assist in generating better planning strategies by gathering, verifying, and analyzing real-time data for real-world problems (Buyukozkan & Gocer, 2019).
Cloud Computing, defined by Marston et al. (2011), represents "an information technology service model where computing services (both hardware and software) are delivered on-demand to customers over a network in a self-service fashion, independent of device and location". All services are provisioned and accessed from a Cloud Computing provider. Using Cloud Computing can contribute to scalability, agility, and low costs (Assante et al., 2016).
Big data and analytics refer to the strategy of analyzing large volumes of data used when traditional data mining and handling techniques cannot uncover the insights and meaning of the underlying data (Bai et al., 2020). Big data can create real-time solutions to challenges in every industrial sector. The last decade has witnessed intense progress in companies' revenues that employed Big Data technologies in their businesses. However, due to a lack of expertise in Big Data technologies, many SMEs cannot earn broad benefits from it (Iqbal et al., 2018).
Additive manufacturing (3D printing) is a manufacturing technology that creates three-dimensional (3D) solid objects using a series of additive or layered development frameworks that could be employed

by almost any industrial sector (Dorrington et al., 2017). The process consists of successive printing layers of materials formed on top of each other (Ngo et al., 2018).

The Internet of Things is a concept for thinking about things in an environment where various objects and subjects are connected by wire and wireless. International Telecommunication Union interprets the Internet of Things as an intelligent environment in which communication modules embedded in devices and objects are connected to a wired or wireless network. That way enables information exchange and communication between people and objects and among objects helping them enhance manufacturing and industrial processes (Shin, 2017).

Virtual Reality refers to complete, 3D virtual representations of the actual world or objects within it, while Augmented Reality refers to integrating the actual world with digital information.

In Virtual Reality, a person is placed in a computer-generated world. The idea behind VR is that person is separated from the 'real' world and experience the virtual world as being real. In augmented Reality, the real world is augmented by computer-generated content (Farshid et al., 2018).

Artificial intelligence is an area of computer science that emphasizes the creation of intelligent machines that work and reacts like humans. Although all business units are dependent on the human workforce, still, it's possible to carry out business activities at greater efficiencies using Artificial Intelligence and technologies. Today, Artificial Intelligence can analyze all the activities performed by consumers online to study their behaviour and computing possibilities through an algorithm, manage demand supply, and perform back-end operations (Kumar & Kalse, 2021).

Mentioned Industry 4.0 related technologies are unknown in SMEs. Broader acceptance of these technologies requires further in-depth understanding and developments (Bai et al., 2020).

3. DECISION-MAKING METHODOLOGY USING TOPSIS AND ENTROPY WEIGHTS METHODS

Multi-Criteria Decision Making (MCDM) approaches began to be developed in the 1960s, seeing the need for new approaches to assist decision making (Buyukozkan & Gocer, 2019). Since the modern business environment involves decision-making considering many different criteria, multi-criteria decision methods are imposed as the ideal solution. Precisely the Reality in which more and more complex decisions are made has conditioned the rapid development of methods used in solving even the most complex problems of multi-criteria analysis (Buyukozkan & Gocer, 2019). These methods involve determining the optimal alternative among multiple, interactive and conflicting criteria (Jahan & Bahraminasab, 2016).

In the process of multi-criteria optimization is very important to understand the preferences of the decision-maker and adequately develop the model by which these preferences are presented. In each model of multi-criteria decision making, the decision maker's preference is expressed by aggregating the values of the functions associated with the individual criteria. In practice, the sum of weights is most often used and applied as an aggregation function because this function has low complexity and is easy to use. However, other aggregation functions can also be used successfully (Hwang & Yoon, 1981).

The search for various optimal solutions and decisions has implied the development of many methods and multi-criteria decision-making techniques that have been proposed and developed within scientific disciplines such as operations research, management, computer science, statistics and others (Saaty, 1980; Hwang & Yoon, 1981; Zavadskas et al., 1994; Chang & Chen, 2011; Jahan & Bahraminasab, 2016; Lu et al., 2019; Arsić et al., 2020). Today, combined with the development of information technology, many of these methods have well-developed software support.

Also, to assess technology selection problems, using MCDM methods are gaining more popularity (Mukull et al., 2019). Moreover, a continuing increase has been seen from day to day.
In order to assess the current state of the level of implementation of Industry 4.0 related to technologies, six European countries (Hungary, Poland and Slovakia, Czech Republic, Serbia and Bulgaria) were ranked using the TOPSIS method. Additionally, the Shannon Entropy method was employed (Tang et al., 2019).

3.1. Entropy weights method

In the MCDM approach, one of the main issues is to find an appropriate weight for each criterion. Shannon's entropy method is one of the methods for finding weights when obtaining a suitable weight based on the preferences, and decision-maker experiments are not possible. The mathematical theory of communication was proposed by Claude Shannon (1948). Today is widely employed in numerous fields of research (Lotfi & Fallahnejad, 2010; Hafezalkotob & Hafezalkotob, 2016; Ijadi Maghsoodi et al., 2019). In the process of decision making the proposed method can be effectively used because in information theory it can be considered as criteria for the degree of uncertainty represented by a discrete probability distribution, and it measures existent contrasts between sets of data and clarifies the average intrinsic information transferred to the decision-maker (Hafezalkotob & Hafezalkotob, 2016; Lu et al., 2019). The procedure of Shannon's entropy method to determine the objective weights can be defined in the next steps:
Step 1. Normalize the decision matrix.

$$p_{ij} = \frac{x_{ij}}{\sum_{j=1}^{m} x_{ij}}, \qquad j = 1,\ldots,m; \quad i = 1,\ldots,n \tag{1}$$

The raw data are normalized to eliminate anomalies with different measurement units and scales. This process transforms different scales and units among various criteria into common measurable units to compare different criteria (Lotfi & Fallahnejad, 2010).

Step 2. Computation of the entropy measure of project outcomes using the following equation:

$$E_j = -k\sum_{i=1}^{m} p_{ij} \ln p_{ij}, \quad \text{in which} \quad k = 1/\ln(m) \tag{2}$$

Step 3. Defining the objective weight based on the entropy concept:

$$W_j = \frac{1 - E_j}{\sum_{i=1}^{n}(1 - E_j)} \tag{3}$$

Calculating the general form of the entropy weight, if the decision-maker assigns subjective weight s_j. By considering s_j, Eq. (3) transforms into the following:

$$W_j^* = \frac{s_j w_j}{\sum_{j=1}^{n} s_j w_j} \tag{4}$$

in which subjective and objective weights (s_j and w_j) are combined to produce the general form of Shannon entropy weight w_j^* .

3.2. TOPSIS method

TOPSIS (Technique for order performance by similarity to ideal solution) method is the most commonly used multi-criteria decision-making method. Hwang and Yoon developed this method for solving an MCDM problem (Hwang & Yoon, 1981). TOPSIS concentrates on choosing the alternative with the smallest distance from the positive ideal solution and the longest distance from the negative ideal solution. The best alternative is closest to the positive ideal solution and the furthest from the negative ideal solution (Behzadian et al., 2012; Oturakci, 2019; Lu et al., 2019; Singh et al., 2019). The distance from the worst-case scenario is to get the closeness of each target to the ideal scenario. The closeness value is between 0 and 1. The closer the value is to 1, the closer the corresponding evaluation target is to the optimal level. On the other hand, the closer the value obtained to 0, the

closer the evaluation target is to the worst level (Hu, 2002; Zhao & Gong, 2018; Koyuncu et al., 2021).
The advantage of the TOPSIS method is that it is easy to understand and apply. The disadvantage of this method is the difficulty of determining weight factors, and they are very important for calculating distances (Seiti & Hafezalkotob, 2019).
The selection of the best alternative using the TOPSIS method was obtained through the following five steps (Behzadian et al., 2012):
First, the initial matrix is normalized, equation (1):

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}} \tag{5}$$

Each element of the normalized matrix is multiplied by the corresponding weight criteria w_j and in this way the elements v_{ij} of the normalized weight matrix V are obtained:

$$V = \left\| v_{ij} \right\| = \left\| W_j * r_{ij} \right\|, \quad \sum_{i=1}^{n} w_j = 1 \tag{6}$$

The next third and the fourth steps are the formations of an ideal positive and an ideal negative solution. For each alternative A_i, the components A^+ of the positive ideal solution and A^- of the negative ideal solution are determined by equations (7, 8):

$$A^+ = \left\{ \left(\begin{matrix} max \\ i \end{matrix} v_{ij} | j \in J' \right) and \left(\begin{matrix} min \\ i \end{matrix} v_{ij} | j \in J'' \right) \right\} = \\ \left\{ v_1^+, v_2^+, \ldots, v_j^+, \ldots, v_n^+ \right\}, i = 1, 2, \ldots, m \tag{7}$$

$$A^- = \left\{ \left(\begin{matrix} min \\ i \end{matrix} v_{ij} | j \in J' \right) and \left(\begin{matrix} max \\ i \end{matrix} v_{ij} | j \in J'' \right) \right\} = \\ \left\{ v_1^-, v_2^-, \ldots, v_j^-, \ldots, v_n^- \right\}, i = 1, 2, \ldots, m \tag{8}$$

Where in:

$J' \subseteq J \rightarrow J'$ is a subset of the set J when it consists of criteria of type max;
$J'' \subseteq J \rightarrow J''$ is a subset of the set J when it consists of criteria of type min.
The distances (Euclidean distance) of each alternative from the ideal positive and ideal negative solution are calculated using equations (9, 10).

$$S_i^+ = \sqrt{\sum_{j=1}^{n} \left(v_{ij} - v_j^+ \right)^2} \tag{9}$$

$$S_i^- = \sqrt{\sum_{j=1}^{n} \left(v_{ij} - v_j^- \right)^2} \tag{10}$$

Then, the relative proximity of the alternative to the ideal solution is calculated, equation (11):

$$C_i = \frac{S_i^-}{S_i^- + S_i^+}, 0 \le C_i \le 1 \tag{11}$$

Finally, the rank of alternatives was obtained. The range of C_i values arranged in descending order corresponds to alternatives A_i from best to worst (Behzadian et al., 2012).

4. APPLICATION OF DECISION-MAKING METHODOLOGY TO SELECT BENCHMARK COUNTRY

In order to examine the current situation and establish the facts about the level of application of Industry 4.0 in six European countries from July to November 2021, a survey was conducted using a questionnaire. Due to the specific situation due to the COVID-19 pandemic, the survey was conducted through an online questionnaire. A total of 546 respondents, 33% employees, 32% owners, and 55% managers participated in the research. Only 45% of respondents are familiar with Industry 4.0 related technologies.
In this research, the Shannon Entropy method was used to determine the weight of the defined criteria and the TOPSIS method to obtain the final rank of the countries. The possibility of adaptation of the

proposed approach in a multi-criteria decision environment was the motive to select these methods.

4.1. Weights of criteria obtained by Shannon Entropy method

Within the defined research model, six countries are ranked according to the following eight criteria: Cloud Computing, Big Data Analysis, 3D printing and robotics, Internet of Things Virtual Reality, Augmented Reality, Supply Chain Management, and Artificial Intelligence. The defined criteria are presented in Table 1.

Table 1. List of the criteria used in a country selection

No.	***Criteria***	***Symbol***
1	Cloud Computing	CC
2	Big Data Analysis	BDA
3	3D printing and robotics	3DaR
4	Internet of Things	IoT
5	Virtual Reality	VR
6	Augmented Reality	AR
7	Supply Chain Management	SCM
8	Artificial Intelligence	AI

Table 2 shows a decision matrix formed on the information obtained from the questionnaire about digital technologies conducted in six European countries.

Table 2. Decision matrix for all analysed countries

Criteria→ ↓Alternatives	**CC**	**BDA**	**3DaR**	**IoT**	**VR**	**AR**	**SCM**	**AI**
Serbia	3.39	2.95	2.90	2.87	2.92	2.68	2.99	2.96
Hungary	3.44	2.05	2.39	2.23	2.34	2.06	2.11	2.31
Poland	2.44	2.03	2.54	2.21	2.42	2.02	2.63	2.64
Slovakia	3.34	2.90	2.81	2.85	2.73	2.53	2.86	2.83
Bulgaria	2.38	1.84	1.64	2.30	1.84	1.81	2.25	1.90
Czech Republic	2.71	2.80	2.88	2.58	2.60	2.32	2.68	2.69

The calculated values of the average of each criterion are shown in Table 3 in the form of the normalized matrix.

Table 3. Normalized decision matrix (Entropy weight method)

Criteria→ ↓Alternatives	**CC**	**BDA**	**3DaR**	**IoT**	**VR**	**AR**	**SCM**	**AI**
Serbia	0.191	0.202	0.191	0.191	0.197	0.200	0.192	0.193
Hungary	0.194	0.141	0.158	0.148	0.158	0.154	0.136	0.151
Poland	0.138	0.139	0.168	0.147	0.163	0.150	0.170	0.172
Slovakia	0.189	0.199	0.185	0.190	0.184	0.188	0.184	0.185
Bulgaria	0.134	0.126	0.108	0.153	0.124	0.135	0.145	0.124
Czech Republic	0.153	0.192	0.190	0.171	0.175	0.173	0.173	0.176

The computed information of the degree of diversification d_j and the objective weight of each criterion are shown in Table 4.
The comparison of the percentage of weight between different country selections criteria is shown in Figure 1. BDA (Big Data Analysis) possesses the highest weightage of 20.53%, and 3DaR (3D printing and robotics) has the second-highest weightage, 18.27%.

Table 4. The Entropy weights calculations of the given criteria

Criteria→ ↓Alternatives	**CC**	**BDA**	**3DaR**	**IoT**	**VR**	**AR**	**SCM**	**AI**
Serbia	-0.317	-0.323	-0.316	-0.316	-0.320	-0.322	-0.317	-0.317
Hungary	-0.318	-0.276	-0.291	-0.283	-0.291	-0.288	-0.271	-0.285
Poland	-0.273	-0.275	-0.299	-0.282	-0.295	-0.285	-0.301	-0.303
Slovakia	-0.315	-0.321	-0.312	-0.315	-0.311	-0.315	-0.312	-0.312
Bulgaria	-0.270	-0.261	-0.241	-0.287	-0.259	-0.270	-0.280	-0.259
Czech Republic	-0.288	-0.317	-0.315	-0.302	-0.305	-0.303	-0.303	-0.306
SUM	-1.780	-1.774	-1.776	-1.786	-1.782	-1.783	-1.784	-1.782
H_j	0.993	0.990	0.991	0.997	0.995	0.995	0.996	0.994
D_j	0.007	0.010	0.009	0.003	0.005	0.005	0.004	0.006
W_j	0.1342	0.2053	0.1827	0.0681	0.1108	0.1023	0.0836	0.1129
Weight (%)	13.42	20.53	18.27	6.81	11.08	10.23	8.36	11.29

In general, criteria Big Data Analysis and 3D printing and robotics showed the highest weights. Under the initial technical parameters, the weights of these two criteria are 0.2053 and 0.1827. On the other hand, the criteria Internet of Things had the lowest priority with a value of 0.0681 (Table 4).

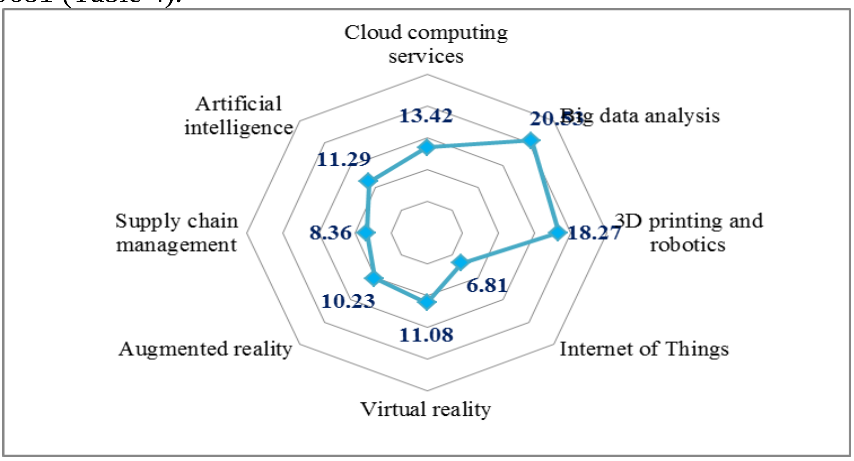

Figure 1. Weightage percentage using Entropy weights method
Source: Author

4.2. Ranking countries using the TOPSIS method

To rank the countries and determine the position that the Republic of Serbia has, the TOPSIS method was used. The data used for ranking are presented in Table 5.

Table 5. Weighted normalized matrix using TOPSIS method

Criteria→ ↓Alternatives	CC	BDA	3DaR	IoT	VR	AR	SCM	AI
Serbia	0.464	0.487	0.462	0.464	0.477	0.484	0.468	0.468
Hungary	0.470	0.339	0.381	0.362	0.382	0.373	0.330	0.366
Poland	0.333	0.335	0.405	0.358	0.395	0.365	0.413	0.418
Slovakia	0.457	0.479	0.447	0.462	0.446	0.457	0.448	0.448
Bulgaria	0.325	0.304	0.261	0.373	0.301	0.328	0.353	0.300
Czech Republic	0.371	0.462	0.458	0.417	0.425	0.420	0.420	0.426

After the application of the TOPSIS method for ranking six European countries, which was based on objective entropy weights, produced the following results (presented in Table 6) for the calculated values of Ideal Separation (Si^+), Negative-Ideal Separation (Si^-), and Relative Closeness to the Ideal Solution (C_i*). The graphical representation of obtained results is depicted in Figure 2.

Table 6. Average performance and rank of each alternatives

↓Alternatives	Si^+	Si^-	Ci*	Rank
Serbia	0.001	0.065	0.986	1
Hungary	0.041	0.033	0.442	4
Poland	0.042	0.033	0.439	5
Slovakia	0.006	0.060	0.905	2
Bulgaria	0.065	0.002	0.032	6
Czech Republic	0.018	0.054	0.750	3

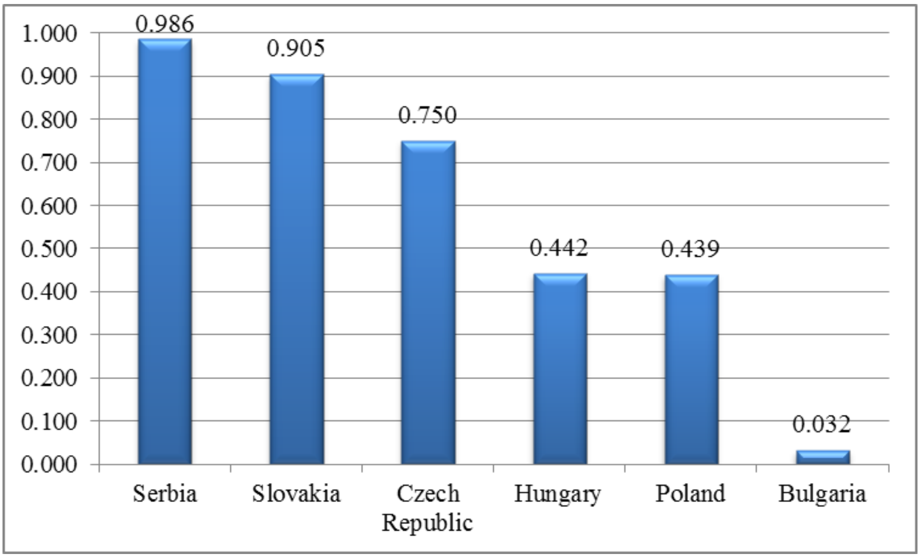

Figure 2. Position of the country in the final rank
Source: Author

Analyzing the Visegrad group (Czech Republic, Poland, Slovakia, Hungary) as well as Serbia and Bulgaria, according to the results presented in Table 6, which are based on the level of using Industry 4.0 related technologies, it can be seen that alternative - Serbia has the best rank (0.986). Slovakia follows it with a very small difference (0.905). The third rank is the Czech Republic (0.705), followed by Hungary and Poland (0.442 and 0.449, respectively). The worst-ranked country with a low rate of application of digital technologies in business among those surveyed is Bulgaria (0.032).

5. DISCUSSION OF RESULTS

The analysis of individual Industry 4.0 related technologies in itself already provides insight into the positions of the analyzed countries (Table 2). Although certain conclusions can be drawn in this way, the overall position of analyzed countries in relation to the level of application of various digital technologies in Industry 4.0 requires the

application of more complex methods. Therefore, much more concrete conclusions can be drawn using the integrated Entropy-TOPSIS methodology used in this research.
The Shannon Entropy method was used to achieve these goals to determine the most significant indicator within the eight analyzed criteria. Based on the objective assessments of the respondents were obtained, it was determined that Big Data Analysis and 3D printing and robotics are the technologies that are most important for the development of Industry 4.0 in SMEs in considered countries.
Based on the results obtained using the TOPSIS method, it can be concluded that no grouping of countries according to membership in the European Union (EU) has been observed. Namely, the best rank has the Republic of Serbia, which is not a member of the EU. The analysis showed that it has the highest level of implementation of modern digital technologies related to Industry 4.0. After the Republic of Serbia, Visegrad countries are followed (Slovakia, Czech Republic, Hungary and Poland, respectively). The results showed an approximate result for Hungary and Poland. The worst-ranked was Bulgaria, which has a lower level of application of digital technologies.
Additionally, one of the conclusions of this research is that respondents in the analyzed countries are generally poorly acquainted with the concept of Industry 4.0. Accordingly, SMEs should actively cooperate with universities and other educational organizations to develop educational programs that cover several areas such as programming, engineering, mathematics, analysis and data processing. These findings align with Ríos et al. (2017) and Kiel et al. (2017). These findings can contribute to raising awareness of the importance of applying digital technologies related to the concept of Industry 4.0.
Horváth and Szabó (2019) determined that Management aspiration to increase control and enable real-time performance measurement may be a significant driving force for introducing technologies Industry 4.0. While on the other hand, one of the barriers that can significantly hinder companies from introducing Industry 4.0 technologies are companies concerns about profitability and uncertainties in tendering procedures. Additionally, organizational resistance appears to the

introduction of new technologies. If not properly handled, organizational resistance can significantly impede the successful introduction of new technologies.

6. CONCLUSION

The attention devoted to Industry 4.0 by scholars, managers and policymakers has grown exponentially in the last few years. The digitization and automation of manufacturing are the main features associated with Industry 4.0. This research, conducted in six European countries (Hungary, Poland, Slovakia, the Czech Republic, Bulgaria and the Republic of Serbia), analyses the current state of digital technologies applied within the concepts of Industry 4.0 in SMEs performed. In order to find out which of the mentioned countries is the best ranked concerning using different digital technologies, the integrated Entropy-TOPSIS method was employed. Based on the results, it can be concluded that Serbia is the best positioned among the analyzed countries, while Bulgaria is the worst-ranked. Serbia is a country aspiring to join the European Union, therefore SMEs are investing significant efforts in the modernization and development of industrial processes in order to reduce dependence on human labour and decision-making.

The concept of Industry 4.0 is leaning into digital solutions. Generally, enterprises, in order to keep up with the times, must realize advances in networking, 3D printing and robotics, machine learning, big data analytics, and other technologies that are making comprehensive improvements to industrial processes. The application of advanced digital technologies can reduce human error, shorten time to market, and increase the speed at which industrial processes can adapt to new information.

The volume of literature on the concept of Industry 4.0 is limited because this concept is still relatively new. This is why further research questions are constantly being asked in this field. In the future, researchers can explore management aspects and best practices in SMEs implementing Industry 4.0. Additionally, it is necessary to consider the main barriers and difficulties enterprises face in Industry 4.0 implementation. In this research, only six European countries were analyzed. Therefore, it may be helpful to extend the geographical focus of Industry 4.0 research to compare similarities and differences across countries.

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ASSESSING THE READINESS OF SMEs FOR INDUSTRY 4.0 IN V4 AND SERBIA – ROLE OF GOVERNMENT POLICY, LABOR MARKET AND TAX SYSTEM

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Abstract

The Industry 4.0 paradigm is one of the most current topics among researchers, policymakers, and managers. It includes emerging technologies that can integrate business processes and provide digital solutions that can help firms achieve the higher flexibility required by the market. This shift has inevitable obstacles, which are even more deeply embedded in the case of SMEs. Factors such as government policy, labour market, and tax system characteristics may significantly impact these organizations' preparedness to change their business operations and adapt to digital era development. Considering that, this article aims to investigate the readiness of SMEs in the V4 countries and Serbia for the transition to Industry 4.0. The World Bank Enterprise Survey data for 2099 SMEs from these countries were used for the probit model, and the results show that labour market characteristics have the greatest impact on SMEs' readiness.
Keywords: *Industry 4.0, SMEs, Process innovation, Government policy, Labour market, Tax system*

Possibilities and barriers for Industry 4.0 implementation in SMEs in V4 countries and Serbia

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1. INTRODUCTION

In recent years, firms, researchers, and governments have been paying close attention to Industry 4.0 since its implementation may lead to competitive advantages for businesses and national economies (Culot et al., 2020; Masood & Sonntag, 2020). More efficient value creation, customization of products and services, flexibility and better cost mapping, improved quality of products and services, reduced long-run operational costs and lead times, reduction of life-cycle costs, increased customer satisfaction, improved worker safety, and reduced environmental impacts are among the most commonly cited benefits of Industry 4.0. (Kamalaldin et al., 2021; Oesterreich & Teuteberg, 2016; Peukert et al., 2015; Sony et al., 2021).

There is still no consensus on the definition of Industry 4.0. However, it primarily relates to the concept of factories in which machines are upgraded with intelligent and autonomous systems powered by the Internet of Things (IoT), 3D printing, Artificial Intelligence (AI), machine learning, big data, augmented reality, and other technologies (Büchi et al., 2020). These digital solutions are intended to act as embodied sources of process innovation for processing industry firms. Considering the numerous benefits of the Industry 4.0, policymakers in many countries have proposed different regulations, strategies, and policies aimed at energy conservation, sustainable development, and industry transition (Fedajev et al., 2020; Lin et al., 2017, Radulescu et al., 2018).

Despite the fact that policymakers in most countries have provided a supportive institutional environment for the transition to Industry 4.0, there is a lack of readiness among enterprises to adopt and implement Industry 4.0. It's one thing to decide to adopt Industry 4.0 and quite another to put it into practice properly, considering that there are no standardized approaches to its implementation. First, it's essential to identify the barriers to Industry 4.0 acceptance before implementing (Butt, 2020). Adoption of Industry 4.0 would not only test a company's ability to innovate, but it would also require new strategies, organizational models, and organization-wide changes in physical infrastructure, manufacturing operations/technologies, human resources, management of practices, and change management (Dalenogare et al., 2018; Ruggieri et al., 2016; Tortora et al., 2021).

SMEs have to adopt modern manufacturing and management technology to stay up with the competition, as required by the Industry 4.0 idea. SMEs that cannot keep up with technology advancements cannot compete with larger firms in the same industry. SMEs utilize technology in a somewhat different way than larger companies with more possibilities and resources. The solutions appropriate for large firms do not necessarily fit SMEs, highlighting the need for further research on this topic (Machado et al., 2021). This need is more explicit in V4 countries and Serbia. Their economies are primarily comprised of SMEs, with specific institutions and legislation to support initiatives for increasing employment and generating innovative activities. SMEs in these economies still struggle to integrate ICT into their daily business activities (Sevinc et al., 2018).

SMEs have some different characteristics compared to large companies that are important to consider when analyzing and evaluating Industry 4.0 relevance and practice for SMEs (Blili & Raymond, 1993; Buonanno et al., 2005; Nooteboom, 1994; Zach et al., 2014):

1. SMEs have fewer resources and experience in managing new technologies;
2. SMEs are very flexible in adapting new technologies and catering niche markets, whereas large enterprises are better on scale efficiencies but slower in adapting innovations;
3. CEO involvement in daily business activities and predominant focus of CEO at the expense of strategic and development-oriented activities.

Therefore, there are at least four reasons why studying the obstacles of ICT adoption in SMEs related to Industry 4.0 is essential (Nooteboom, 1994; Müller & Hopf, 2017; Prause, 2019):

1. SMEs have a higher share in the total number of enterprises compared to larger enterprises, thus representing a considerable target group for digitalization;
2. SMEs operate with fewer resources than large enterprises;
3. SMEs are often less bureaucratic and have greater incentives to succeed than large enterprises;
4. SMEs have greater possibilities for accelerating the dissemination of new technology.

Considering all the above mentioned facts, this study attempts to sketch the cross-national comparison of V4 countries and Serbia regarding the government policy, labour market and tax system role in the transition towards Industry 4.0 and to access the impact of mentioned factors on SMEs process innovations, as an indicator of their readiness for Industry 4.0.

In the following section, a review of recent literature is presented to provide a brief summary of the relevant work carried out so far. Section 3 briefly describes our methodology and the dataset used in our analysis. Section 4 presents descriptive statistics based on the collected data, and Section 5 introduces the model and presents the results of our tests. The final section gives relevant discussion and a summary of the obtained results.

2. LITERATURE REVIEW

There are many papers dealing with obstacles for Industry 4.0 implementation from micro and macro points of view. The majority of them aim to examine challenges and factors influencing Industry 4.0 adoption. The challenges, barriers, and limitations of Industry 4.0 are limited to the application of new technologies and include the economic and social aspects and outcomes of this transformation (Aoun et al., 2021). So, there are many different points of view on this issue considered in current literature in this research area.

A common understanding of Industry 4.0 implications, lack of clarity about the standards for implementing Industry 4.0, inability to precisely estimate return on investment, legal issues, insufficient R&D investment, data ownership, insufficient government support, lack of digital culture, lack of digitally educated workforce, inefficient tax incentives, lack of top management commitment, lack of infrastructure and internet access are just some of the challenges to Industry 4.0 adoption (Kiel et al., 2017; Luthra & Mangla, 2018; Machado et al., 2021; Raj et al., 2020). Considering the characteristics of observed countries and SMEs specificities, the following factors were selected for this research: government policy, labour market, and tax system.

2.1. Government policy

In various cases, the emergence of new technology may raise broad policy concerns. The ability of governments to design and implement appropriate regulations and policies is a crucial component of effective technology adoption. Governments must respond quickly to create, amend, and enforce laws, regulations, standards, and even certification programs in response to new technology that changes existing business structures. They also need to create a legal framework that protects people, ensures fair competition, and fosters innovation and entrepreneurship.
As the competition increases, digitalization poses some legal challenges. While implementing a digital strategy, laws about data protection, artificial intelligence liability, and standardization must be considered (Christians & Liepin, 2017). The virtual organization cannot be identified as a legally independent entity without a legal personality. Every virtual organization that uses ICT must ensure that data is transferred securely, that privacy standards are not violated, and that the concluded contracts are lawful and enforceable (Kamble et al., 2018). Aside from security concerns, which lower the probability of criminal activity, there are a variety of government initiatives that support Industry 4.0 adoption. To enable an efficient transition to Industry 4.0 and realize the benefits of its implementation, policymakers should eliminate corruption and informal sector

competition, increase the availability of financial sources and create a simulative tax system. In this context, the importance of mentioned aspects of government policy is presented below.

2.1.1. Crime

Given the possibility of cybercrime emergence due to data sharing and online transactions, laws in this area should target the indistinct legal state concerning external data usage. Data privacy and confidentiality are essential issues for providers, manufacturers, and other stakeholders, so they should be considered during the adjustments of laws and regulations. Since extensive data usage continues to transform industries and enterprises from all sectors to exploit its potential, big data-related privacy issues are increasing. However, the legislative reforms are too slow to keep up with the rapid changes accompanying the transition to Industry 4.0.

In the context of Industry 4.0, the shift to digitalization, cyber-physical systems, interconnected devices, and real-time communication puts a spotlight on the generated data and its preservation. Manufacturers and consumers are increasingly concerned about cyber security. Individuals and organizations use a combination of policies and practices to monitor computers, networks, programs, and data in order to protect them from being subjected to illegal access or attacks for exploitation purposes. Cyber hazards can cause irreparable harm to a company. The manufacturing industry is particularly vulnerable to intellectual property theft, data integrity difficulties, cyber-physical damage, employee safety, and productivity losses. Standardization of cyber security protocols is also required to create confidence in a user company (Ani et al., 2017).

Furthermore, greater connectivity resulting from, for example, complex links across value-chain partners raises widespread concerns about the security risks of exchanging data among partner companies (Geissbauer et al., 2014). In Industry 4.0, it's not just about companies' cyber-security concerns. It's also about their fear of losing their data to third-party software and service providers. According to Lee and Lee (2015), Hackers would pose a severe threat, and this risk is one of the potential challenges in Industry 4.0 adoption. In this regard, it should be concluded that minimizing the probability of criminal activity through effective legislation in this area will result in the overall development of process innovation regarding the usage of ICT technology in everyday company activities.

2.1.2. Corruption

Considering that all observed countries are former command economies characterized by a relatively high level of corruption as their heritage from a centrally-planed system, the policies aimed at corruption are among top priorities for efficient implementation of Industry 4.0. The country's widespread corruption has a negative impact on all aspects of doing business (Virglerova et al., 2021), especially process innovation. According to Huang and Yuan (2021), political corruption impedes firms' motivation to innovate and proposes two ways: the disincentive effect and the culture effect. They used the viewpoints of Murphy et al. (1993) and Ayyagari et al. (2014) to examine the disincentive effect, proposing various reasons why entrepreneurs and innovative enterprises are more likely to be targeted by corrupt officials:

1. Innovators generally have a high and inelastic demand for government-supplied goods like licenses and permits, and hence must interact with government officials who may have the ability to extort the company;
2. The politicians are more prone to target innovators because their innovations may jeopardize the interests of firms closely connected to politicians;
3. The majority of innovative projects are long-term, giving corrupt government officials more opportunity for rent-seeking;
4. In transition countries, innovators pay more bribes than non-innovators but do not receive better services, implying that

political corruption works as a tax on innovating enterprises by raising their expenses;

5. Ex post-rent-seeking is especially prone to innovative projects since they have a significant tail risk. Entrepreneurs and innovators may be required to share rents with corrupt government officials when creative projects succeed, but they must bear the entire cost of the projects fail.

On the other hand, the culture effect can be explained using sociological and political science literature that shows that government quality influences people's judgments of others' trustworthiness and that governmental corruption reduces social trust (Rothstein and Eek, 2009; Richey, 2010; Uslaner, 2004). This means that corruption can emerge into a national culture that impacts people's actions. Because innovation relies heavily on collaboration among innovators, and successful collaboration requires confidence from all parties involved, it's reasonable to assume that reduced social trust generated by a corrupt national culture will result in lower innovation efficiency (Huang & Yuan, 2021). In other words, even when companies have strong incentives to innovate, a lack of social trust among innovators can lead to poor collaboration and, as a result, reduced process innovation, which is critical for the transition to Industry 4.0.
Considering all these facts, it can be assumed that higher corruption would reduce innovators incentives to innovate.

2.1.3. Practices of the informal sector

As a result of growing market competitiveness, businesses are more motivated to innovate their business operations and follow global business trends. It is undoubtedly true for formal-sector competition, although the impact of informal-sector competitors is, to some extent, controversial. While Spulber (2013) claims that informal competition among producers reduces incentives to innovate, Galdón-Sánchez & Schmitz (2002) and Symeonidis (2002) both find that informal competition has a favourable influence on innovation and productivity.

To analyze the impact of the informal sector on competitiveness, the informal sector should be defined first. The International Labor Organization (2002) defines informal economy as "all economic activities by workers and economic units that are - in law or practice - not covered or insufficiently covered by formal arrangements." Bearing in mind this definition, it is reasonable to conclude that competition from this sector can influence the innovative activities of formal sector enterprises, notably through lower costs and the avoidance of laws. SMEs are especially vulnerable to such negative market conditions, which can significantly influence their readiness to digitalize their operations due to their limited capacities and financial resources. Also, formal and informal businesses compete for the same clients and resources (McGahan, 2012). In terms of access to inputs like human capital, the presence of a large informal sector may distort the process of skills accumulation. This is because the readily available jobs in the informal sector, which typically require low skills, may discourage the accumulation of human capital, making this factor scarcer.

While most competitors in developed countries are formal enterprises, many legal firms in transition economies compete directly against informal firms. In transition economies, the presence of a strong informal sector may be a factor limiting formal firms' innovation strategies (Mendi & Costamagna, 2017). According to institutional theories, the institutional context effectively constrains the behaviour of businesses (Peng et al., 2009). Meyer and Peng (2016) claim that institutional factors are more likely to change in transition countries. As a result, companies' actions are more likely to be context-specific than in developed economies with more stable institutions. Institutions and the informal sector are inextricably linked because the country's institutional framework may partly explain the informal sector. The presence of an informal sector may impair institutional efficiency.

According to Mendi and Costamagna (2017), informal enterprises' activities are a serious barrier to formal firms' innovations, and current innovations are failing to protect formal firms' competitiveness. Their empirical investigation revealed that informal competition has a different influence depending on whether process or product innovations are considered. They found that informality had a greater impact on process innovations than product innovations. This is in line with an environment in which most innovations are product innovations that are mostly imitative and characterized by a low return. Such an environment makes the returns from process innovations low: while processes are difficult to imitate, formal firms expect low returns on investments due to constricted margins. In transition countries, it is generally easier to introduce a new variety of products than redesign manufacturing procedures, especially if the firm lacks the necessary competencies to either produce new technology ex-novo or adapt frontier knowledge. Hence, industries under intense competition from informal firms are discouraged from developing innovations, particularly new processes. Then, informal enterprises gain strategic benefits from their informality, but formal firms confront unfair competition that higher levels of innovation cannot neutralize. Accordingly, policymakers should consider providing incentives to promote standard technological development and, as a result, improve the quality of goods consumed. Legal protection such as property rights or patents is a mechanism to protect formal enterprises' ideas from the informal competition. Informality is a structural problem, implying that it is a shared responsibility that both policymakers and companies, so both parties must address it. Therefore, policymakers and companies must coordinate innovation policies and strategies in order to increase the volume of innovation activity. Otherwise, formal enterprises' inventions will decline, and potential innovation spillover effects will be lacking. All of these arguments led to the conclusion that the presence of a strong informal economy reduces SMEs' willingness to innovate their business processes and, as a result, to transition to Industry 4.0.

2.1.4. Access to finance

As previously, stated, increased digitalization of business processes has several financial benefits, including a significantly lower cost for human resources, inventory management, and operations. On the other hand, the significant financial resources required to transition to Industry 4.0 may impede the process and raise concerns about profitability and investment return (Aoun et al., 2021; Jones et al., 2014). According to Geissbauer et al. (2014), companies interested in implementing Industry 4.0 projects must commit to increasing annual capital investments by 50% for the next five years. This not only means that companies must rethink their current strategy, but it also means that achieving Industry 4.0 targets would require a significant investment. For many companies, such an investment approach is out of reach. These worries are amplified for SMEs that lack sufficient internal financial resources and have restricted access to financial resources on the financial market.

Decision-makers positive attitudes about Industry 4.0 are harmed by a lack of necessary resources for its adoption. Firms can generate finances by borrowing from banks or allocating budgets from other planning expenses if they are short on introducing new information systems. Financial support from central or local governments may effectively compensate enterprises' lack of funds regarding the Industry 4.0 adaptation. Firms incur costs in implementing information systems, procuring equipment and devices, looking for partners, and hiring experts. It is a crucial barrier for Industry 4.0 adaptation. Government financial support might lower costs for businesses and accelerate Industry 4.0 adoption across the country (Hamada, 2019).

Given these facts, access to external funds can be considered a significant aspect of an SME's ability to innovate (Schneider & Veugelers, 2010). SMEs that engage in innovation activities face a high level of risk, which results in a higher cost of finance to compensate for this risk, or financial providers refuse to fund their innovative projects. The government should implement an incentive credit strategy for the SME sector to lower the risks and costs of innovation activities. Implementing such a policy will boost the digitalization of SMEs' business activities and, as a result, the transition to Industry 4.0.

2.2. Labor market

Firms' requirement for skilled people for planning, monitoring, and supervising industrial processes and facilities will rise due to the introduction of a new information system (Stock and Seliger 2016). If SMEs realize they lack such experts, they will postpone or abandon Industry 4.0 implementation. On the other hand, if the company employs experts and experienced individuals with knowledge and skills for Industry 4.0 and related technologies, key decision-makers may recognize the importance of adapting to Industry 4.0, resulting in progress in digitalization. As a result, companies with sufficient experts adapt to Industry 4.0 quickly, whereas firms lacking trained workers with knowledge of Industry 4.0 would take longer to adjust (Hamada, 2019).

The employees' skills and qualifications will become the key to the success of highly innovative SMEs with the deployment of Industry 4.0. Employees with the appropriate knowledge and skills remain critical among the non-technical obstacles that Industry 4.0 faces. According to Geissbauer et al. (2014), under-qualified people are the second key impediment to implementing Industry 4.0, as firms become more data-driven and agile, requiring a more skilled workforce. Depending on their qualifications, tasks, and positions, employees are affected differently by the shift to Industry 4.0. SME's that adopt digital technologies have a higher percentage of highly skilled employees. Automation impacts process data management, physical labor, product packaging, storage, and transfer jobs. Conversely, communicative and intellectual vocations requiring a high education level are less vulnerable to automation (Aoun et al., 2021).

Apart from changes in employee qualification structures, Cor and Volpe (2020) discovered that enterprises that implement modern digital technologies tend to increase employment in the short term, which is why they recognize labour regulations efficiency. If labour regulations are too complex and rigid, hiring necessary workers will be delayed and inefficient, delaying the adoption of Industry 4.0. The main conclusion that can be derived from the above arguments is that effective labour legislation and the availability of skilled workers in the labour market can improve process innovation in SMEs, hence facilitating Industry 4.0 adoption.

2.3. Tax system

With government policy and the labour market, the tax system can also contribute towards a business-friendly environment for SMEs to innovate. Germany has been a pioneer in the industrial application of digital technology in the European context, combining traditional governmental instruments, such as R&D subsidies and tax deductions, with bottom-up initiatives to collectively envision the direction of change (Prodi et al., 2021).

Governments offer tax incentives in developed and developing countries to encourage foreign direct investment (FDI) and stimulate firm growth (Harger & Ross, 2016). These goals allow a country to generate profitable income, capture mobile capital, and motivate companies and investors to keep and expand their current operations. Governments around the world have devised many tax incentives, including reinvestment allowances to encourage business expansion, automation, modernization, and diversification (Hamid et al., 2018), corporate tax policies and value-added tax (VAT) policies (Wang & Kesan, 2020), subsidy and tax rebates (Majumdar et al., 2021), and tax credits (Majumdar et al., 2021). (Greenhalgh & Rogers, 2010).

According to Wang & Kesan (2020), the Chinese government formulates tax policies to increase R&D incentives. These tax policies matter more to SMEs than intellectual property (IP) policies. Corporate tax policies and value-added tax (VAT) policies are the most important tax policies created by the Chinese government for stimulating innovation and supporting SMEs. These two tax policy reforms aimed to promote IT industry innovation and growth, but it has been proven that corporate tax policies are more effective in fostering IT sector innovation. According to Majumdar et al. (2021), the government and industry actors should collaborate to develop supporting national policies for Industry 4.0 through subsidies and tax rebates, removing the fear of failure from entrepreneurs' minds. To boost innovators' incentives to engage in R&D, tax credits have been proposed (Greenhalgh & Rogers, 2010). The economic logic is that the tax credits, when coupled to the private return from R&D, boost the total return to innovators and pay them more effectively (Hall et al. 2014). Regardless of the form of tax incentives, the tax system is one of the most critical factors that might influence the transition to Industry 4.0.

3. MATERIAL AND METHOD

3.1. Data collection

The data used in this study originates from the World Bank Enterprise Survey (WBES) databases, which contain firm-level data (The World Bank, 2019). The economies from various geographical regions worldwide are included in the survey data. The surveys have been conducted since 2006 to offer insight into firms' innovation activities. The WBES is one of the most extensive databases available to researchers (Wang, 2016; Okumu et al., 2019; Ndiaye et al., 2018; Aidoo, 2019).
The WBES survey a representative sample of a country's private sector conducted at the firm level. The survey covers a wide range of topics related to the business climate, including access to capital, corruption, infrastructure, crime, competition, and performance metrics. The most important advantage of this survey is its broad coverage of small and medium-sized businesses. The Enterprise Survey (ES) uses stratified

random sampling as a sample method. The ES is stratified according to three criteria to representativeness: industry sector, firm size, and geographical location.

The Enterprise Survey's respondents are firm owners and top managers in most cases. Still, company accountants and human resource managers are also interviewed regarding labour force characterization and sales questions. The World Bank hires private contractors to collect data due to the confidential nature of some survey questions. These surveys are typically conducted in collaboration with businesses and government agencies that promote job creation and economic growth, with every effort made to ensure that the respondents' privacy is protected. The WBES dataset provides a representative sample of each country's firm performance indicators and business environment characteristics. The sample is composed of a list of eligible firms obtained from each country's statistical office. If there are any gaps, an additional list of businesses is obtained from (1) other government agencies such as tax or business licensing authorities and (2) business associations or marketing databases. Only formal businesses with five or more employees are targeted in the survey.

This paper uses the World Bank Enterprise Survey dataset of 2099 service and manufacturing firms from four Visegrad countries (Hungary, Czech Republic, Poland and Slovakia) and Serbia (Table 1). Since the focus of the study is on SMEs, firms with a total number of employees not greater than 99 (OECD, 2005), all large firms (100 employees and above) are deleted from the database.

Table 1. Number of SMEs by country

Country	No of SMEs
Hungary	495
Czech Republic	355
Poland	773
Slovakia	303
Serbia	172
Total	

Source: World Bank Enterprise Survey

As shown in Table 1, the number of SMEs varies across the analyzed countries in accordance with the total number of SMEs in these economies.

4. DESCRIPTIVE STATISTICS

Table 2 presents the percent and proportion of workforce employed in the observed companies for each country.
Concerning firm size, it can be seen (Table 2) that the largest percentage of small companies that offer formal training is recorded in Slovakia. However, when it comes to medium-sized companies, the Czech Republic is a leader. Interestingly, a very small percent of surveyed companies in Poland, both small and medium-sized, offer formal training to their employees. Observing data related to the number of skilled workers out of all production workers, it is very large percent, above 60%, and in most small companies, even greater than 80 %.
Table 3 shows the 15 obstacles and the percentage response for each one, by country and firm size.

Table 2. The structure of employees in SMEs across observed countries

Firm size	Country	Percent of firms offering formal training	Proportion of workers offered formal training (%)*	Proportion of permanent workers (out of all workers)	Proportion of temporary workers (out of all workers)	Proportion of production workers (out of all permanent workers)*	Proportion of skilled workers (out of all production workers) (%)*
Small	Czech Republic	38.2	53.0	95.6	4.4	72.3	80.7
	Hungary	22.1	37.1	81.0	19.0	81.0	84.1
	Poland	19.2	50.0	97.8	2.2	78.4	80.8
	Slovak Republic	40.0	80.8	96.3	3.7	72.4	78.0
	Serbia	30.7	56.4	97.4	2.6	68.2	81.2
Medium	Czech Republic	57.3	56.1	91.0	9.0	74.3	67.0
	Hungary	46.5	42.9	76.8	23.2	70.6	80.6
	Poland	37.2	42.8	99.6	0.4	78.2	69.7
	Slovak Republic	43.0	62.7	95.0	5.0	77.9	65.4
	Serbia	47.2	62.9	96.8	3.2	74.5	73.7

Source: World Bank Enterprise Survey

Table 3. Major obstacles for doing business across analyzed countries and firm size

Firm size	Country	Access to finance	Access to land	Business licensing and permits	Corruption	Courts	Crime, theft and disorder	Customs and trade regulations	Electricity	Inadequately educated workforce	Labor regulations	Political instability	Practices of the informal sector	Tax administration	Tax rates	Transportation
		Percent of firms choosing as their biggest obstacle:														
Small	Czech Republic	4.7	1.6	2.2	2	0.3	2	2.5	1.8	26.7	6.3	4.2	8.7	9.4	16.7	11.1
	Hungary	4.4	0.2	0.7	0.3	0	1.1	1	0.4	27.2	3.1	0	9.8	11.2	32.5	8
	Poland	3.3	2.1	1.4	2	2.2	0.6	3.1	3.8	10.7	5.5	6.9	6.2	10	37.8	4.5
	Slovak Republic	3.2	0.7	8.6	4.7	1	2	1.8	9.3	14.2	13.4	3.8	10.2	2.6	19.2	5.5
	Serbia	8.6	1.9	1.5	5.7	3.6	0.5	8.3	1.8	15.1	1.5	22.2	18.7	0	9.5	1.1
Medium	Czech Republic	3.4	0	2.9	0	0.8	0.3	1.6	0.7	35.6	13.5	7.1	12.1	8.5	6.8	6.7
	Hungary	0.1	0	0.3	0.1	2.9	0	2.2	0.1	39.2	3	4.5	11.4	4.7	16.7	14.9
	Poland	9.5	7.1	2.4	7.1	5	0.2	1.4	3.8	12.9	8.2	5.9	5.5	7.1	23	0.8
	Slovak Republic	0.4	1.6	5.8	7.7	1.4	3.5	4.5	7.7	21.2	6	1.7	7.7	2.7	10.9	17.4
	Serbia	7.2	1.2	5.9	5.4	2	2.6	1.6	1.1	21.2	2.1	7.7	24.2	0	17	0.7

According to the results presented in Table 3, the inadequately educated workforce is the top of the second most important obstacle across all firm sizes and countries. Tax rates and practices of competitors in the informal sector are also marked as one of the most pronounced obstacles. Surprisingly, access to finance only appears as a sixth or seventh on the list.

Competition from the informal sector appears as an especially great constraint for doing business in the Republic of Serbia (chosen by 18.7 % of respondents in small-sized or 24.2% respondents in medium-sized firms). Studies have shown that the firms affected the most by competitors from the informal sector resemble them the most, namely, small firms serving markets with low entry costs. The perception of different obstacles in Serbia also varies according to firm size (Panic et al., 2019). Small-sized firms tend to find that barriers related to political instability have a more severe impact on their performance than medium-sized firms.

Tax rates are highly problematic for businesses in Hungary (32.5 %), Poland (37.8 %) and Slovakia (19.2%), but much less in the Czech Republic and Serbia. According to their impact on business, performance is the tax rates, and it has the greatest effects on small businesses employing 5-19 employees. It can be explained by the fact that, according to an OECD survey, out of 34 participant countries, Hungary is ranked at the fourth position according to the income tax rate. The tax rate amounting to 49%, which the Hungarians paid in 2014, is high, and it is particularly obvious if it is compared to the OECD average amounting to 38% (OECD, 2015). Certain reforms in the tax system would improve the business environment in these countries, particularly for small businesses.

In order to take an insight into innovative activities and usage of technology in SMEs of analyzed countries, Table 4 present some important indicators in this area.

Table 4. The level of innovative activities and usage of technology in SMEs in analysed countries

Firm size	Country	% of firms using technology licensed from foreign companies	% of firms having their own Web site	% of firms that introduced a new product/service	%of firms whose new product/service is also new to the main market	% of firms that introduced a process innovation	% of firms that spend on R&D
	Czech Republic	6.7	86.6	27.9	63.6	9.1	12.4
	Hungary	2.7	72.9	16.0	80.1	9.3	3.8
	Poland	9.4	60.2	19.1	64.3	4.6	1.9
	Slovak Republic	24.0	79.0	10.0	49.8	6.3	2.2
Small	Serbia	6.3	74.3	35.4	36.8	19.9	10.3
	Czech Republic	21.6	94.9	39.0	55.8	30.8	37.7
	Hungary	22.2	77.7	27.2	75.4	15.2	11.5
	Poland	18.7	75.5	24.3	38.0	16.2	5.9
	Slovak Republic	39.4	96.2	21.4	85.0	9.0	12.8
Medium	Serbia	19.3	86.1	46.6	60.2	32.6	15.7

Source: World Bank Enterprise Survey

Research and Development (R&D) activity is a key element of SMEs' innovation activities. R&D allows employees to acquire and enhance their technical know-how and apply their tacit knowledge to innovate processes and products (Aidoo, 2019). It is not surprising that the percentage of firms that spend money on R&D is closely related to the rate of firms that introduced process innovation (Table 4). However, a significant percentage of those firms that introduced product innovation compared to per cent of firms that spend on R&D shows that the SMEs in these countries, probably due to a lack of internal resources, rely on the knowledge, technical know-how and technology from other institutions to help them fulfil their R&D goals.

5. THE MODEL

5.1. Variables

This section will describe the selection of variables used in this paper and their features. The dependent variable in this analysis is the process innovation, and it is a dummy variable. The respondents were asked to indicate on a dummy scale whether their companies introduced any new or improved process during the last three years (Yes=1, No=0), where the process includes methods of manufacturing products or offering services; logistics, delivery, or distribution methods for inputs, products, or services; or supporting activities for processes. This variable was selected as a dependent, taking into account that most process innovations aim to introduce the ICT in mentioned business activities, which is in line with the transition to Industry 4.0. In the world of the Fourth Industrial Revolution, which is currently taking place, some processes are expected to be simplified, and others to become much more complex and embedded. In such circumstances, companies are becoming increasingly interested in applying new technologies to ensure long-term competitiveness. However, there are a variety of obstacles that could hinder companies' efforts to be innovative and adopt the concept of Industry 4.0.
The independent variables are the obstacles for companies' business performance perceived by respondents, which are continuous variables. These variables were selected as the most important for process innovation according to literature review. A variable "training" is also an independent. It comes from the question "Over fiscal year, did this establishment have formal training programs for its permanent, full-time employees?" It is a dummy variable, if the answer is YES than is set as "1", otherwise "0". The dependent and independent variables were described in Table 5.

Table 5. Description of variables

Dependent (D) and Independent (I) Variables	
Process Innovation	Dummy variable: Yes -1, No - 0
Corruption	Continuous variable : No obstacle – 0, Minor obstacle– 1, Moderate obstacle – 2, Major obstacle – 3, Very severe obstacle -4
Crime, theft and disorder	Continuous variable : No obstacle – 0, Minor obstacle– 1, Moderate obstacle – 2, Major obstacle – 3, Very severe obstacle -4
Access to finance	Continuous variable : No obstacle – 0, Minor obstacle– 1, Moderate obstacle – 2, Major obstacle – 3, Very severe obstacle -4
Practices of competitors in the informal sector	Continuous variable : No obstacle – 0, Minor obstacle– 1, Moderate obstacle – 2, Major obstacle – 3, Very severe obstacle -4
Tax rates	Continuous variable : No obstacle – 0, Minor obstacle– 1, Moderate obstacle – 2, Major obstacle – 3, Very severe obstacle -4
Tax administration	Continuous variable : No obstacle – 0, Minor obstacle– 1, Moderate obstacle – 2, Major obstacle – 3, Very severe obstacle -4
Formal training of the full-time employees	Dummy variable: Yes -1, No - 0
Labor regulation	Continuous variable : No obstacle – 0, Minor obstacle– 1, Moderate obstacle – 2, Major obstacle – 3, Very severe obstacle -4
Inadequately educated workforce	Continuous variable : No obstacle – 0, Minor obstacle– 1, Moderate obstacle – 2, Major obstacle – 3, Very severe obstacle -4

Source: World Bank Enterprise Survey

5.2. Pairwise Correlations between Independent Variables and Process Innovation

A pairwise correlation analysis is conducted on the dependent and independent variables to determine the statistical significance of all the factors. The relationship between all the independent variables and the dependent variable (process innovation) is shown in Table 6.

Table 6. Correlations between Independent Variables and Process Innovation

Variable	New process	Competitors in informal sector	Crime	Finance	Tax rate	Tax admin	Corrup-tion	Training	Labor regulation
New process									
Competitors in informal sector	0.008								
Crime	-.051*	0.496**							
Finance	-0.010	0.409**	0.561**						
Tax rate	-0.019	0.309**	0.354**	0.356**					
Tax admin	-0.025	0.317**	0.400**	0.422**	0.634**				
Corruption	-0.027	0.397**	0.499**	0.397**	0.430**	0.471**			
Training	0.157**	-0.030	-0.032	-0.032	-.061**	-0.041	-0.029		
Labor regulation	-0.063	0.291**	0.437**	0.438**	0.405**	0.447**	0.382**	-0.049	
Inadequate workforce	0.069**	0.210**	0.243**	0.293**	0.301**	0.293**	0.259**	0.050*	0.430**

**. Correlation is significant at the 0.05 level (2-tailed).*
***. Correlation is significant at the 0.01 level (2-tailed).*

The results reveal statistically significant positive correlation coefficients between employees' training (corr = 0.157), inadequate workforce (corr =0.069) and process innovation. However negative and statistically significant correlation coefficient is obtained between crime as a perceived obstacle (corr = -0.051) and dependent variable.

5.3. The Pearson Chi-square test of independence

The research also employed the Pearson Chi-square test of independence to determine whether there is a statistically significant relationship between categorical variables, in this case, between perceived obstacles and innovations' activities. Two categorical variables (introduced process innovation and obstacle type) are considered independent if all joint probabilities are equal to the product of the marginal probabilities (Table 7). In this case, the null hypothesis would be defined in that all companies have the same perception of a certain obstacle regardless of their innovative activity, which is rejected if the p-value is less than the critical level (for example, 5%).

Table 7. Difference between innovative and non-innovative companies

Obstacles	Perception of obstacle Percentage of companies	Process Innovation Percentage of companies reporting this obstacle	Chi2 p-value
Competitors in informal sector	61.5	63.4	0.538
Crime	43.8	37.7	0.044*
Finance	50.5	49.4	0.739
Tax rate	80.8	77.0	0.108
Tax admin	68.8	65.8	0.281
Corruption	49.3	45.1	0.162
Labor regulation	82.2	77.4	0.036*
Inadequate workforce	87.7	88.7	0.685

**p - value lower than 0.05*

When testing the null hypothesis of whether the presence of obstacles is independent in relation to innovative activity, the results from Table 7 indicated that Chi^2 is significant for labour regulations and crime, revealing that these obstacles are not independent in relation to the innovations' activity.

5.4. The probit model

This section presents the results of the regression analysis. The purpose of this investigation is to determine the probability of introducing process innovations using responses from the WBES regarding respondents' perceptions about certain obstacles to their business performance. The aim is to identify obstacles that could jeopardize the probability of introducing process innovations in current market conditions.

In order to realize this purpose, the econometric models linking the status of innovation in the past three years 2016-2019 (as dependent variable) with selected independent variables measured in 2019 were defined.

Because the dependent variable is binary, classical linear regression models for estimation can't be used. Most frequently, the models used in the case of a binary dependent variable are logistic regression and probit analysis (Astudillo and Briozzo, 2021; Wang, 2016). Both methods estimate the probability of Pi that the dependent variable for observation i is equal to 1 based on a linear combination of independent variables (Lahiri & Yang, 2013). Distribution functions for both these models are similar. Probit models have become quite popular to predict the default probabilities of companies. The regression coefficients of the probit model are effects on a cumulative normal function of the probabilities that Y = 1. They are already in a metric that can easily be understood: the metric of a standard normal score. Using this, one can interpret the coefficients directly. It is important to note that probit models are generally estimated using the maximum likelihood technique. The estimation model in this study can be expressed as:

$$Yi = \beta_0 + \beta_{corruption} + \beta_{crime} + \beta_{finance} + \beta_{competition} + \beta_{tax\_rate} + \beta_{tax\_admin} + \beta_{training} + \beta_{labor\_reg} + \beta_{unqualified\_workforce}$$

where Y is the outcome variable which represents whether firm i introduced innovative process in the last three years.
The estimates include the values of the regression coefficients β, the values of Wald's statistics (Table 8), and test probabilities used to assess the significance of the variable in the regression model and exp (β). Wald's statistics are used to test the significance of explanatory and constant variables.

Table 8. The effects of probit regression

			95% Wald Confidence Interval		
Variables	β	Std. Error	Lower	Upper	Exp (β)
Corruption	-.014	.0379	-.088	.061	.721
Competitors in informal sector	.054	.0353	-.016	.123	.129
Crime	-.084	.0471	-.177	.008	.073
Finance	.021	.0401	-.058	.099	.605
Tax rate	.005	.0384	-.070	.080	.902
Tax administration	-.014	.0413	-.095	.067	.739
Training	.485**	.0735	.341	.629	.000
Labor regulation	-.146*	.0455	-.235	-.057	.001
Inadequate work force	.151**	.0368	.079	.223	.000

The results show that the binary probit model performs well in explaining process innovation activity in the observed SMEs (Table 8). As expected, the coefficient of formal employees' training is positive and highly significant, indicating that training is an important factor that affects whether or not to introduce a new process. The coefficient of variable "inadequate workforce" is also positive and highly significant, indicating that companies which perceived this obstacle as necessary are more likely to engage in innovative activities. The coefficient of "labour regulation" is negative and significant as expected, revealing that firms considering this factor as a big constraint

is less likely to innovate their business processes. The regression coefficient for other observed factors is not statistically significant, indicating that they are not considered a big obstacle for process innovation. This led to the conclusion that labour market-related factors represent the main precondition of Industry 4.0 adoption in analyzed countries.
To assess variable "process innovation" variations among observed countries, separate regression analyses for all five countries (Hungary, Czech Republic, Poland, Slovakia and Serbia) were conducted. The Omnibus test results are presented in Table 9.

Table 9. Comparative results of probit regression for selected countries

	Dependent Variable - Process Innovation					
	Hungary		Poland		Slovakia	
	β	Std. Error	β	Std. Error	β	Std. Error
Corruption	0.128	0.1012	-0.084	0.0817	0.038	0.1246
Competitors in informal sector	0.058	0.0743	0.053	0.0744	-0.137	0.1393
Crime	-0.446	0.2174	-0.176	0.1003	-0.145	0.1520
Finance	0.056	0.1099	0.072	0.0783	0.140	0.1461
Tax rate	0.004	0.0836	0.228*	0.0824	0.223	0.1404
Tax administration	0.035	0.0932	-0.120	0.0846	-0.070	0.1597
Training	0.380*	0.1544	0.455*	0.1677	0.473	0.2414
Labor regulation	-0.225*	0.1019	-0.030	0.1150	-0.314	0.2072
Inadequate work force	0.21**	0.0630	0.104	0.0898	0.580*	0.1985

**p value lower than 0.05*
*** p-value lower than 0.01*

As shown in Table 9, the same independent variables were used, as in the case with pooled data, for comparison purposes. However, the Omnibus test results (comparing the fitted model against the intercept-only model) revealed that in the case of Czech Republic and Serbia, the p-value is more significant than 0.05, which means that results obtained in the regression analysis are not reliable and statistically significant. That is why only the remaining three countries' results will be presented (Table 9). As it can be seen, most of the variables maintained their sign and statistical significance with minor changes, compared with the main model. Still, it is interesting that when it comes to Poland, the results showed that the coefficient of variable "tax rate" is positive and statistically significant, which was not the case with the whole model. In the case of Slovakia, the only similarity with the main model was observed in connection to the variable “inadequate workforce”, while the other variables were not significant. The most similar results to one from the main model were obtained using the data from Hungary.

According to Economy Briefs (2020), the Visegrad countries are not fully prepared for the Industry 4.0 transition. The situation is the same when it comes to Serbia. Business digitalization and the use of e-commerce is relatively high only in the Czech Republic, but Hungary and Poland are among the worst performers in the EU. Current education and training systems do not appear prepared to support the coming technological changes. OECD data shows that less than 20% of low skilled employees in Slovakia receive firm-based training, compared to around 40% in the Czech Republic (almost 80% in the Scandinavian countries). In addition, only 40% of the medium-skilled in Slovakia and Poland get training, compared to 60% in the Czech Republic (OECD 2015).

However, it is difficult to compare the results obtained in this study with other studies because, analyzing the literature, it was concluded that most researchers used perceived barriers as dependent variables. In contrast, the characteristics of the firm (age, size, ownership) and innovative activities were used as an independent. Investigating the link between innovative activities and barriers to doing business in Argentina and Ecuador, Astudillo and Briozzo (2021) found that in the case of Argentine firms, a statistically significant link exists regarding finance, political instability, labour regulation and inadequate workforce and crime. When it comes to Ecuadorian firms, the connection was noticed only in the case of corruption. Similar results related to corruption were obtained by Xu and Yano (2016) and Pavlov (2016).

6. DISCUSSION AND CONCLUSION

As mentioned in the literature, small and medium enterprises are the backbone of each country's economy. The assumption is that due to their size, these companies are more flexible, easier to adapt to changes and introduce innovations in their business. On the other hand, certain factors hinder or slow down their innovative activities. Most often, these are resources, both financial and human, due to which these companies do not introduce innovations often enough and quickly enough as expected of them.

Most of the Visegrad countries are emerging innovators according to the 2021 European Innovation Scoreboard, except the Czech Republic, a moderate innovator. Currently, most innovation in the Visegrad Group is generated by foreign-owned firms. As expected, many innovations (product or process) are lower in smaller, mostly domestic firms. The situation is the same when it comes to Serbia. Based on the same report, Serbia was defined as an emerging innovator.

In this paper, an effort has been made to identify and analyze the most common barriers that affect the performance of small and medium enterprises and link them to their innovative activities. For the needs of the study, the data of the World Bank for 2019 were used for four countries of Visegrad Group and Serbia. Independent variables were selected based on the literature review, combined with data on which barriers were marked as the most significant by the respondents.

The results obtained using probit regression showed that companies whose owners perceive obstacles related to the workforce as the most important have a higher probability of dealing with innovative activities. It can be said that they understand very well how insufficiently qualified workforce or employees' training can endanger, i.e. contribute to successful innovations. It is surprising. However, that tax system and government policy do not have a statistically significant connection with innovative activities, which are often the biggest obstacle for process innovation in the current literature.

This study contributes to the existing literature and discussion on barriers to the innovation of small and medium enterprises. Although most respondents recognized the importance of a skilled workforce and formal training on their company's innovation, the data show that the money they invest in their training is not in line with this. Unfortunately, this is most often limited funding intended to raise the qualification level of employees. The findings from this research will enable the government to understand which directive or policy is needed to enhance the capacity of human capital in both SMEs and vulnerable firms which intend to innovate.

As one of the biggest limitations of this and all studies based on World Bank data, it is reasonable to ask whether the perception of respondents about the impact of certain barriers to their business is relevant or is too subjective and should be taken with a certain dose of the reserve, when interpreting the results. In addition, this study included only data related to five countries on different scientific, technological, and innovative levels. Serbia is neither a member of the Visegrad Group nor a member of the EU. Subsequent analysis of individual countries showed that each has its specifics, which should be respected before presenting general conclusions.

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THE EFFECT OF DIGITALISATION ON SUSTAINABLE OPERATION OF SMEs – THE CASE OF HUNGARY

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Abstract

Digitalisation as the megatrend for industrial and business transformation influences SMEs to various extent. Depending on the sector and the size or even the age of SMEs digitalisation becomes beneficial or even means some limitations to further business development. The present research paper as part of the international project on the 'Possibilities and barriers for Industry 4.0 implementation in SMEs in V4 countries and Serbia' explores the attitude of Hungarian SMEs towards digitalisation and investigates what SMEs in Hungary consider as benefits and drawbacks of digitalisation. The results show that while Hungarian SMEs do not experience special pressure for digitalisation from the regulatory bodies and find that digitalisation helps them to operate in a cost-effective way, it also reveals that the advantages of social media and possible software usages are not exploited and limited human resource or finance hinder the digitalisation process.
Keywords: *DESI, digitalisation, SME, Digital maturity, Digital intelligence, Digital economy*

1. INTRODUCTION

Digitisation is defined differently and used in different ways in recent literatures. Even the use of the term ’digitisation’ (binary conversion) and the understanding of digital transformation is confusing. The fact that some of the terms have changed over time, disappeared or are now used in a completely different sense, makes it even more difficult to interpret certain concepts. In this paper, the concept of digitalisation is understood as the innovation of business models and processes that exploit digital opportunities. Digital transformation, on the other hand, is the transformation of the economy, institutions and society through digital diffusion (Gubán & Sándor, 2021). More in depth, in corporate terms digitalisation means turning interactions, communications, business functions and business models into (more) digital ones which often boils down to a mix of digital and physical as in omnichannel customer service, integrated marketing or smart manufacturing with a mix of autonomous, semi-autonomous and manual operations. In Clerk's definition, digitalisation is centred on digital information (Clerk, 2021).
The megatrend of digitalisation, that was already dominant before the pandemic, has been further strengthened by recent events, reinforcing the need for digital transformation of market players in different sectors. Companies no longer compete on products but on activities, as digital services blur the boundaries between sectors and companies (Éltető, 2021). SMEs, which are the backbone of the economy, are no exception, and therefore it is crucial for them to keep pace with technological/technical developments (Marcysiak & Pleskacz, 2021). Micro, small and medium-sized enterprises employed 2.1 million people in Hungary in 2019, contributing 45% of the total value added by enterprises, while these small firms accounted for three tenths of the investments in the year (Hungarian Central Statistical Office, 2020). Financial resources are just as important for the digitalisation of SMEs as the will of business leaders. While digital maturity models (Gubán & Sándor, 2021; Kljajić Borštnar & Pucihar, 2021; Mittal, Romero, &

Wuest, 2018; Schallmo, Lang, Hasler, Ehmig-Klassen, & Williams, 2021) can help to assess the current state of businesses, the ability of managers to integrate, build and reconfigure internal and external resources to adapt to rapidly changing environments is also crucial (North, Aramburu, Lorenzo, & Zubillaga, 2019).

This study first examines SMEs' software and social media use, and it also aims to reveal whether these companies in Hungary find digitalisation beneficial. The limitations to a higher level of digitalisation perceived by enterprise owners and managers are also under investigation. The research among Hungarian SMEs was carried out within the framework of the Visegrad Fund project 'Possibilities and barriers for Industry 4.0 implementation in SMEs in V4 countries and Serbia' during the period September – December 2021.

The paper formulates four research questions:

RQ1: Is there a pressure on SMEs in Hungary from the regulatory bodies to reach a higher level of digitalisation or SMEs are ambitious to digitalise their processes to a greater extent?

RQ2: To what extent do SMEs use different software, how well do they exploit the potential of social media?

RQ3: Do SMEs with different size, age and in different economic sectors find similar benefits of digitalisation?

RQ4: Do SMEs with different size, age and in different economic sectors find similar limitations of digitalisation?

After the introduction of the essential terms and concepts, the paper presents research methodology and data collection methods, then after presenting the demographic characteristics of the participating SMEs, it presents the quantitative analysis of the participating SMEs' responses. The results section also discusses the findings and implications while conclusions on the research questions are made in the conclusion section.

2. LITERATURE REVIEW

2.1. The theoretical context of digitalisation

According to Dellarocas (2003) digitisation can be captured along three features, namely, creating value at the new frontiers of the business world (1), optimizing processes (2), and building foundations supporting all business activities (3). Digital transformation can affect the organisation in many ways. In many cases, digitalisation can trigger new business models, accelerate technological innovation, bring organizational transformation and reshape project management processes (Csedő, Zavarkó, & Sára, 2019). Wirtz focuses in his book on the description, presentation and analysis of digital business models (Wirtz, 2019). According to him there are six areas that define the digital business models, namely connectivity, data analytics and artificial intelligence, digital platforms, industry 4.0, digital ecosystem with participation of connected and mobile consumers and transformation of scales of economy and cost structure due to technology change. Digitalisation is therefore never achieved within an organization per se. For a successful digital transformation, the right digital business ecosystem (DEE) is essential, which is the matching of digital customers (users and agents) on platforms in digital space through the creative use of digital ecosystem governance and business ecosystem management (Sussan & Acs, 2017). A digital entrepreneurial ecosystem can be established if both the digital and the entrepreneurial ecosystems are developing (Szerb, Komlósi, & Páger, 2020). For the development of the business ecosystem, a change in the mindset of business leaders and owners is essential, as one of the keys to successful digitalisation is leadership support (Csedő, Zavarkó, & Sára, 2019). Rietmann (2021) also highlights the relevance of managerial context of digitization (Rietmann, 2021). Cucculelli et al. 2021 found that ownership structure plays an important role in innovation (Cucculelli, Dileo, & Pini, 2021).

While digitalisation is based on the implementation of new technologies, the digital transformation of the enterprise is as much about people. The digital transformation of SMEs depends not only on the development of infrastructure and an enabling environment, but also on the digital competence of entrepreneurs and employees (Marcysiak & Pleskacz, 2021).

The human factor and the leadership dimensions are also key elements of digital maturity models. Maturity models allow the assessment of the current situation of a company as well as the identification of reasonable improvement measures (North, Aramburu, Lorenzo, & Zubillaga, 2019). Maturity frameworks and models represent how an enterprise's capabilities evolve through different stages along anticipated, desired, or logical paths (Kljajić Borštnar & Pucihar, 2021). Both academic researchers (Gubán & Sándor, 2021; Mittal, Romero, & Wuest, 2018; North, Aramburu, Lorenzo, & Zubillaga, 2019; Schallmo, Lang, Hasler, Ehmig-Klassen, & Williams, 2021) and industry studies (Deloitte, 2020) have defined a variety of models over the last decade. Some of these models interpret maturity as a static state, others understand maturity as a process of state changes (Gubán & Sándor, 2021) Validation of these models has only been partially done (North, Aramburu, Lorenzo, & Zubillaga, 2019), however, their practical implementation is difficult in an SME context for several reasons (Schallmo, Lang, Hasler, Ehmig-Klassen, & Williams, 2021).

Analyses have shown that the revenue growth rate of more digitally mature companies is six times higher than their less digitally mature competitors (Acciarini, Borelli, Capo, Cappa, & Sarrocco, 2021). Despite the perceived positive benefits of digitalisation, we see that Hungarian small businesses are lagging behind their European counterparts. A number of complex indicators can be used to help measure digitalisation in a comparative way. The Digital Economy and Society Index (DESI) is the most popular complex indicator, consisting of five main dimensions and 12 sub-dimensions with 37 indicators in total. The performance of Hungarian SMEs will be presented based on this model in the next section. The European Index of Digital Entrepreneurship Systems (EIDES) measures the digital ecosystem, in which Hungary is one of the worst performers, ranking 24th among EU countries. Likewise, the IMD 2020 Digital Competitiveness Index shows negative results and trends for Hungary, ranking 47th out of 63 countries (Éltető, 2021).

2.2. Digitalisation of Hungarian SMEs in the light of digital economy and society index

The Digital Economy and Society Index (DESI) monitors Europe's overall digital performance and tracks the progress of EU countries in their digital competitiveness (European Commission, 2021). Table 5 presents the evolution of Hungarian companies' DESI ranking among the EU countries between 2016 and 2020. According to the DESI 2021 report, Hungary ranked 21st out of 28 Member States, however, by 2021 it had slipped back to the 25th place (European Commission, 2021). Hungary's calculated score is 41.2 (EU score: 50.7)

Table 5. DESI ranking of Hungary (2016-2020)

	2016	**2017**	**2018**	**2019**	**2020**
DESI ranking (overall)	20	23	23	23	21
1. Connectivity (25%)	16	15	15	14	**7**
2. Human capital (25%)	18	18	19	20	20
3. Internet usage (15%)	11	14	17	18	14
4. Business integration of digital technologies (20%)	27	24	24	25	**26**
5. Digital public services (15%)	24	27	26	26	24

Source: Ministry of Innovation and Technology; Ministry of Internal Affairs (2020)

Over the past few years, Hungary's score has improved at a rate broadly similar to the EU average, however, it scores above the EU average in broadband connectivity thanked to the penetration of broadband services and 5G readiness. In order to understand the reasons behind the poor rankings, Table 6 shows the performances along a selected number of key indicators.

Table 6. Digitalisation among SMEs in Hungary and in EU; %

e-Business	Year	EU average (%)	Hungary (%)
Enterprises with higher level of digital intensity	2020	15.4	10.5
Integration of internal processes (ERP)	2019	34.7	13,0
Use of analytical CRM software	2019	17.8	6.42
E-invoicing	2017	17.1	7.89
Cloud services	2020	35.3	24.3
Using social media	2019	49.6	37.3
Providing portable device to >20% of employees	2017	32	33.1
Enterprises having a fixed broadband connection	2019	91.1	78.5
Enterprises having a fast fixed broadband connection	2019	49.4	41.0
Enterprises where ICT functions are mainly performed by external suppliers	2018	53.5	43.1
Enterprise provided training to their personnel to develop/upgrade their ICT skills	2020	18.3	14.6

Source: European Commission (2021)

The digital intensity score for enterprises is very low (53.3%) or low (36.2%) for almost 90% of Hungarian SMEs, while only 0.268% have a very high score, putting them behind EU enterprises. The most challenging dimensions of the DESI for Hungary remain the integration of digital technology and digital public services. Only 46% of SMEs have at least a basic level of digital intensity, compared to the EU average of 60%, and the uptake of key digital technologies (big data, artificial intelligence and cloud) is also low.

The results suggest that there is a need to identify and exploit the potential of digitalisation to contribute to improving the country's competitiveness. The National Digitalisation Strategy (NDS) 2021–2030 aims for Hungary to surpass the EU average in digital maturity by the middle of the decade and to be among the top 10 EU economies in terms of digitalisation by 2030.

The background to the DESI results is being studied by several Hungarian researchers. Máté's (2020) research highlights that companies are not making sufficient use of the development advantage of digital infrastructure, resulting in a lag in the degree of business efficiency of digital technologies behind the EU average. However, according to the survey, a digitalisation duality (Máté, 2020) can be observed among companies by size, which means that some companies are willing to pursue digital developments and investments, while others are not yet engaged in this process, which will increase their competitive gap in the economy.

A survey among 2500 enterprises in 2020 found that the internet penetration of Hungarian SMEs is high, but there is significant room for improvement in the integration of IT applications into business processes (Csigó, Dobos, & Nemeslaki, 2021). The research also showed that technical challenges and management, business and entrepreneurial attitudinal gaps in SMEs are barriers to successful digital transformation. An interesting finding is that only three of the indicators of digital maturity have a significant positive impact on profitability, namely: (1) the share of employees using a computer or laptop, (2) the share of employees using portable devices and (3) the employment of full-time ICT workers.

Yet according to the 2020 survey by McKinsey&Co., Hungary has great potential in the field of digital technology development. Hungary already has the foundations of digital knowledge and applications that could be used to make a rapid transition in the economy and public administration (McKinsey&Co, 2020). 'Digital transformation could become a new engine of growth for the Hungarian economy in the

forthcoming years, helping to generate an additional €9 billion of GDP by 2025' (Ministry of Innovation and Technology, 2019) .
Therefore, the present primary research seeks to answer what the limitations are for the Hungarian SMEs that cause that they lag behind the EU average and the V4 countries, and what factors prevent firms from increasing their digitalisation development.

3. METHODOLOGY AND DATA

The Visegrad Fund Project "Possibilities and barriers for Industry 4.0 implementation in SMEs in V4 countries and Serbia" provided the framework for the research conducted about the state of digitalisation and its benefits and limitations among SME in Hungary. The questionnaire was designed by the participating countries and was self-administered to collect data from SMEs in Hungary as well as the other participating countries, namely, Serbia, Poland, the Czech Republic and Slovakia. Google form was used for the administration of the questionnaire in each native language. English version was also used for distribution. A pilot of the survey was carried out to confirm the comprehensibility of the questions. The quantitative research used both the online and paper version of questionnaire. Hungarian SMEs were invited to spends 10-15 minutes answering the questions in Hungarian. The questionnaire was disseminated among the respective SMEs in September/October 2021. Anonymity was ensured, no personal information was required. The data gathered 112 valid responses providing a large sample, however, since non-probability method was used to collect data, the dataset does not give a representative sample. Consequently, no generalisation can be made but the results give a general picture about the state of digitalisation of SMEs and even their approach to digitalisation in Hungary.
This paper focuses on the questions linked to digitalisation – 18 questions–, its benefits, external and internal limitations. Furthermore, regulatory bodies' perspective was also considered – 3 questions. Quantitative analysis was carried out to reveal how beneficial SMEs

consider digitalisation and what their perspective about its limitations the statistical programme SPSS version 25 and SAS version 9.4. Descriptive analysis was applied to give a general view of SMEs' approach to digitalisation in Hungary, then ANOVA and agreement analyses were used to reveal whether the different sized and aged companies operating in different economic sectors have different approach towards the benefits and drawbacks of digitalisation.

4. RESULTS

4.1. Demographic features

During the data collection period in September and October 2021 a total number of 112 questionnaires were completed by Hungarian SMEs each of which could be analysed. Due to the non-probabilistic method of data collection the sample is not representative in terms of diversity, however, responses were collected mainly from business owners and managers, which makes the responses relevant about the business itself. In the next section the personal characteristics of the responding business professionals are also presented since the experience and the position of the business professional justify that the findings on SMEs reflect the situation among the SMEs in Hungary.

4.1.1. Personal characteristics of respondents

First, the personal characteristics of the business professionals surveyed are presented. Almost half of the businesspeople surveyed have more than 20 years of work experience (49.11%), almost a third have more than 10 years and more than 10% of the sample have 6-10 years of work experience. In terms of position, 75% of the respondents are company owners, 16,1% are middle managers and 4,5% managers, which means that 95.6% of the respondents work at the tactical and strategic level of the SME they represent. The average age of these business professionals is 46.4 years, with almost half of the respondents (47.3%) aged 46-60. It means that most of the respondents are at least middle-aged with at least 20 years of work experience. Table 7 presents the demographic profile of the responding business professionals.

Table 7. Demographic profile of respondents (n=112)

Personal characteristics	Distribution of respondents (%)
Age	
18-30	6.3
31-45	38.4
46-60	47.3
> 61	8.0
Gender	
Male	68.8
Female	28.6
I do not wish to answer	2.7
Position	
The owner	75.0
Senior manager	16.1
Manager	4.5
Employee	4.5

Source: Author's

4.1.2. Characteristics of the observed SMEs

The demographic features of the SMEs represented in the survey shows (Table 8) that two-thirds of the enterprises surveyed are micro enterprises (66.1%), a quarter are small enterprises (26.8%) and 6.3% are medium-sized enterprises. The enterprises surveyed are mainly active in wholesale and retail trade (21.43%), construction and developers (16.96%), and IT sector (13.39%). A third of the enterprises have been in business for 11–20 years, a quarter for more than 21 years, a quarter for 6-10 years, 8.9% for 3-5 years and only 7.1 % are younger than 2 years. More than half of the enterprises in the sample operate in the services sector, nearly a third in the trade sector and around 10% in the production sector.

Table 8. Demographic profile of participating SMEs (n=112)

SME characteristics	Distribution of SMEs (%)
Company age	
21 years and older	25,0
From 11 to 20 years	33.9
From 3 to 5 years	8.9
From 6 to 10 years	25.0
Up to 2 years	7.1
SME size	
Micro enterprise	66,1
Small enterprise	26.8
Medium-sized enterprise	6,3
Large enterprise	0.9
The dominating sector of the company	
Production	12.5
Services	55.4
Trade	32.1
Area of the company's business activity	
Agriculture	3.6
Construction and developers	17.0
Finance and insurance	3.6
Industry including energy	3.6
Information and communication	13.4
Machinery and equipment	2.7
Manufacturing	6.3
Other sector	28.6
Wholesale and retail trade	21.4
Business focus	
Exclusively domestic market	60.7
Mostly on the domestic market	21.4
Equally on the domestic and foreign markets	13.4
Mostly on the foreign market	1.8
Exclusively to foreign markets	0.9
Our company is a multinational enterprise (MNE) – a member of a group of companies	1.8

Source: Author's

Regarding the area of business SMEs operate in, more than 20% of the enterprises surveyed are in Wholesale and retail trade, 16.96% in

Construction and developers, 13.39% in Information and communication, 6.25% in Manufacturing and less than 4% in Finance and insurance and Industry including energy.

Almost two thirds (60.71%) of the enterprises in the sample are present exclusively on the domestic market, 21.43% of them are doing business mostly on the domestic market and 13.39% make businesses equally on the domestic and foreign market. Due to the nature of the sample, the share of multinational companies is below 2%.

3.2. Social media and software use

In the first part of the section presenting the research results, the use of software by SMEs and their social media presence is described. Around half of the company managers and owners said they do not use software in their business, and according to the answers only 16 companies that incorporate open-source software into their day-to-day operations. This surprisingly low number may be partly due to a lack of understanding of the terms, as it is possible that general office applications (Word, Excel) are not seen as software products that support business operations. According to the answers to the open question 'What software do you use?', the software mentioned can be divided into two broad groups. In terms of mentioned brands, Microsoft (Navision), SAP were mentioned. Among the types of software, ERP, CRM applications as well as those adapted to the specific activity of the company e.g. graphic design software, medical software, GPS tracking systems were listed.

There were also surprising results in terms of social media use. 32% of entrepreneurs surveyed either do not use popular platforms such as Facebook or Instagram at all or only to a small extent, and only 24 business owners or managers said they communicate regularly on these platforms. The proportion is even lower for professional social networks (e.g. LinkedIn), which 75 respondents do not use at all. At the same time, professional communication tools are used by only 30% of the surveyed SMEs.

3.3. Benefits and limitations of digitalisation

The following section discusses in detail what different sized and aged SME in Hungary believe about digitalisation, what they consider beneficial and what limitations they find during their operations. Moreover, their opinion about the regulatory bodies' pressure is also analysed. The responses were ranked on a Likert scale from 1 to 5. Depending on the nature of the responses it ranged from 'no benefits at all' to 'maximum benefits', or 'not important at all' to 'strongly important' and 'totally disagree' to 'totally agree'. Descriptive analysis as well as ANOVA and agreement analyses were conducted.

3.3.1. Benefits of digitalisation in SMEs in Hungary

Table 9 gives a general view how SMEs consider digitalisation. SMEs regardless of size, age or the main economic sector find that digitalisation has beneficial impact on the company's operational performance, financial as well as strategic performance. Most of the responses are on the agreement side with mean higher than 3.48 and the Modes being 4 or 5, the largest proportion of SMEs responded 'maximum' benefit in case of operational performance (MEAN=3.82, Mo=5), and totally agreed with the fact that digitalised processes and services increases productivity (MEAN=3.82, Mo=5) and digital technologies are useful for my business during the COVID-19 pandemic (MEAN=3.82, Mo=5). Most of the SMEs also agreed that digitalised business processes and services increases productivity and enables cost-effectiveness as well as influences the profit and performance of the enterprise.

Table 9. Descriptive measures of benefits of Digitalisation among Hungarian SMEs

Benefits of Digitalisation	**Mean**	**Median**	**Mode**	**SD**	**IQR**
Financial performance	3.63	4	4	1.215	2
Operational performance	**3.82**	4	**5**	1.195	2
Strategic performance	3.63	4	4	1.193	2
Using digitalised processes and services increases productivity.	**3.82**	4	**5**	1.172	2
Investing in digital technologies enable cost-effectiveness.	3.66	4	4	1.234	2
Digitalisation impacts the profit and performances of the company.	3.48	4	4	1.294	2
Digital technologies are useful for my business during the COVID-19 pandemic	**3.82**	4	**5**	1.357	2

Source: Author's

As shown on Figure 10 majority of SMEs agreed that digitalisation is advantageous in financial performance (60.71%), operational (66.07%) as well as in strategic performance (58.93%).

	No benefit	Little benefit	Neutral	Some benefit	Maximum benefit
Financial performance	7.14%	11.61%	20.54%	32.14%	28.57%
Operational performance	6.25%	8.04%	19.64%	29.46%	36.61%
Strategic performance	6.25%	11.61%	23.21%	30.36%	28.57%

Figure 10. Benefits of Digitalisation by SMEs
Source: Author's

SMEs who agreed with the beneficial effect of digitalisation on financial performance think that it brings benefits to operational performance as well ($r=0.6680$, Spearman $\varrho=0.6923$ and weighted $\kappa=0.5161$ (ordinal scale is used)). Since financial and operational performances are part of strategic performance, the agreement between the two first statements strengthen the beneficial impact on strategic performance (Figure 11).

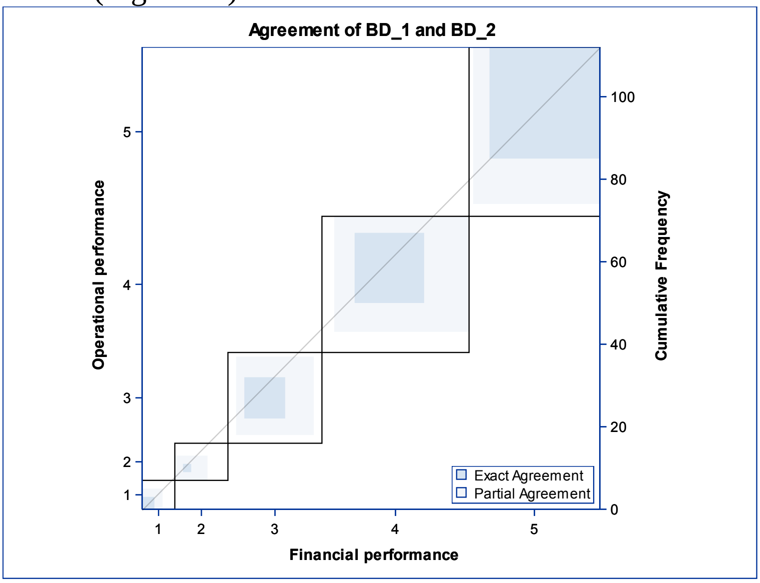


Figure 11. Agreement analysis of financial and operational performance
Source: Author's

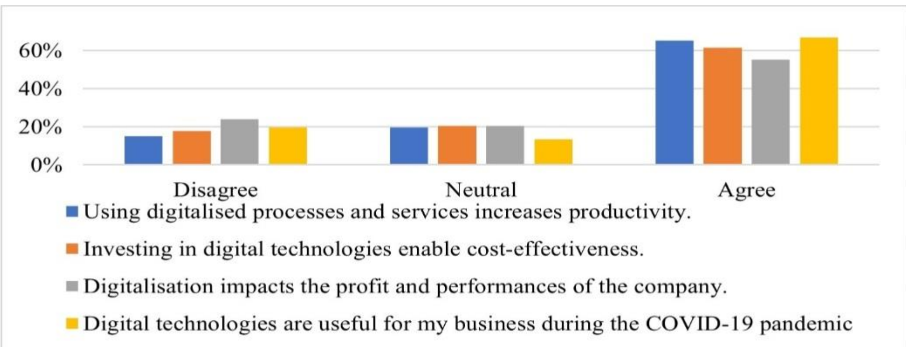


Figure 12. Impact of digitalisation on company performance
Source: Author's

After grouping the responses to ‘disagree’, ‘neutral’ and ‘agree’ the responses even more reflect SMEs approach to digitalisation. Figure 12 displays that two-thirds of the SMES think that digitalisation increases productivity while enables cost-effectiveness and they believe that during COVID-19 pandemic digitalisation helps their businesses. Even more than half of the responding SMEs agreed that digitalisation has an impact on profit and company performance. Twenty or lower than 20% of SMEs disagreed with the statements.
Considering company age and the main economic sectors (production, trade and services), no significant differences were found in the SMEs point of view in respect to the benefits of digitalisation. However, when company size was examined, it was found that micro companies consider the beneficial effects significantly differently compared to small- and medium-sized businesses in case of increased productivity, cost-effectiveness, profit, performance and digitalisation being useful during the pandemic (Table 10).

Table 10. Differences in agreement about benefits of digitalisation by company size

Benefits of Digitalisation	**F**	**Sig.**	**Levene test**	**Sig.**
Using digitalised processes and services increases productivity.	7.843	**0.001**	7.123	0.001
Investing in digital technologies enable cost-effectiveness.	11.779	**0.000**	9.850	0.000
Digitalisation impacts the profit and performances of the company.	10.904	**0.000**	6.861	0.002
Digital technologies are useful for my business during the COVID-19 pandemic	6.204	**0.003**	8.118	0.001
Financial performance	1.425	0.245	3.305	0.040
Operational performance	4.188	**0.018**	6.821	0.002
Strategic performance	3.856	**0.024**	5.062	0.008

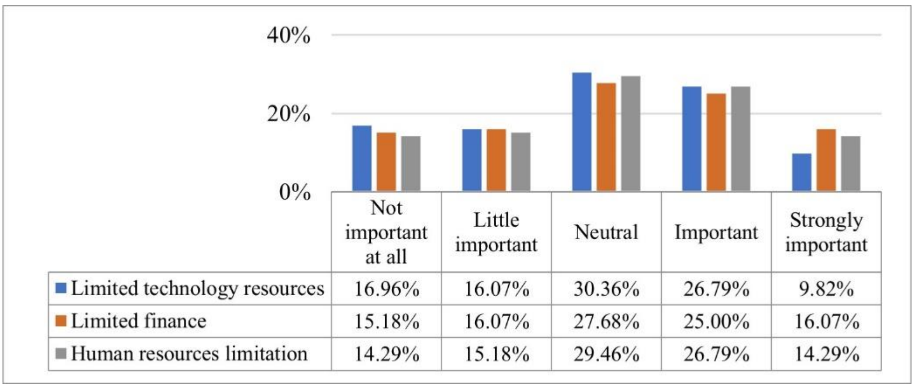
Source: Author’s

In case of operational and strategic performance micro-SMEs’ opinion was significantly different from small-sized SMEs. In each case micro-

SMEs agreed less with the beneficial impacts while small- and medium-sized SMEs agreed more (the Medians were smaller for each question in case of micro-SMEs).

4.3.2. Internal limitations of digitalisation

Even if SMEs find digitalisation beneficial for their operations and performance, it is important to find how these enterprises can be supported in the process of digitalisation. As a further step SMEs were asked to rate what might hinder their digitalisation, thus some internal and external limitations could be examined.
In general higher proportion of SMEs agreed that finance (41.07%), human resources (41.07%) or the lack of well-defined strategy (37.5%) put barriers to higher digitalisation while an approximately even share of SMEs disagreed or agreed that limited technology resources (36.61%) and the lack knowledge (36.61% and 37.5% respectively) are the source of limitations (Figure 13).



	Not important at all	Little important	Neutral	Important	Strongly important
Limited technology resources	16.96%	16.07%	30.36%	26.79%	9.82%
Limited finance	15.18%	16.07%	27.68%	25.00%	16.07%
Human resources limitation	14.29%	15.18%	29.46%	26.79%	14.29%

Figure 13. Limitations to digitalisation – technology resources, finance and human resources – by SMEs in Hungary
Source: Author's

Table 11 presents that even if the Median and the Mode for most of the limitations correspond to the 'neutral' response, the limitations mentioned with an average higher than 3 can rather be considered a barrier to digitalisation.

Table 11. Internal limitations of digitalisation at Hungarian SMEs

Internal Limitations	Mean	Median	Mode	SD	IQR
Limited technology resources	2.96	3	3	1.23	2
Limited finance	**3.11**	3	3	1.29	2
Human resources limitation	**3.12**	3	3	1.25	2
Lack of knowledge	2.96	3	3	1.311	2
Lack of motivation	2.78	3	3	1.25	2
Lack of leadership	2.69	3	**1**	1.288	2
Lack of well-defined strategy of digitalisation	**3.05**	3	3	1.229	2

Source: Author's

Figure 14 presents that 42.86% and 46.63% of the responding SMEs do not believe that motivation or leadership style would hinder digitalisation. For each limitation the porportion of SMEs who are undecisive ranges between 22 and 30% which is detected by the fact that the most frequent response was 'neutral' and the same response split the responding SMEs into two groups. The strongest disagreement could be found in case of 'lack of leadership'.

	Not important at all	Little important	Neutral	Important	Strongly important
Lack of knowledge	18.75%	17.86%	25.89%	24.11%	13.39%
Lack of motivation	18.75%	24.11%	28.57%	17.86%	10.71%
Lack of leadership	24.11%	22.32%	22.32%	23.21%	8.04%
Lack of well-defined strategy of digitalisation	13.39%	18.75%	30.36%	24.11%	13.39%

Figure 14. Limitations to digitalisation – lack of motivation, knowledge, leadership and well-defined strategy – by SMEs in Hungary

Source: Author's

SMEs in Hungary think similarly on the limitations of digitalisation regardless of the age company, while in case of the size of the company the micro- and small-SMEs gives significantly different emphasis on the lack of knowledge as a limitations (F=3.962, p=0.022). Interestingly small- and medium-sized companies agree more with the statement. The human resource limitation was considered significantly differently by SMEs operating in different economic sectors (F==5.479, p= 0.029). Production sector suffers most from human resource problems – rather agreed with the problem –, while service industry seem to be able to employ adequately skilled people – rather disagreed with the statement.

4.3.3. External limitations of digitalisation

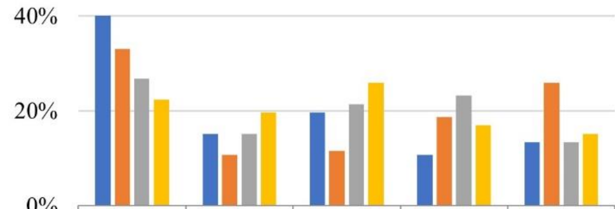
SMEs might suffer not just from internal barriers as limited finance or human resources, some external ones might also prevent them to ahieve a higher rate of digitalisation. Table 12 shows that SMEs do not find power supply, internet accessibility, connection as well as the lack of experienced service providers as barriers since SMEs disagreed with these possible limitations in the highest number (Mo=1, MEAN<3). However, it must be noted that the second highest response option was total agreement in case of internet, which might indicates that SMEs might face fast-speed internet connection problems.

Table 12. General view about external limitations by SMEs in Hungary

External limitations	Mean	Median	Mode	SD	IQR
Power supply	**2.40**	2	**1**	1.449	2
Internet	2.94	3	1	1.635	4
Lack of experienced service providers	2.81	3	1	1.405	3
Lack of external funds for such activity	2.83	3	3	1.362	2

Source: Author's

Differently, SMEs in the highest number were 'neutral' on the question of 'external funds for such activity' (25.89%, Mo=3) while even in this case 41.96% of them disagreed that the lack of external funds would hinder digitalisation (MEAN<3) as seen on Figure 15.



	Not important at all	Little important	Neutral	Important	Strongly important
Power supply	41.07%	15.18%	19.64%	10.71%	13.39%
Internet	33.04%	10.71%	11.61%	18.75%	25.89%
Lack of experienced service providers	26.79%	15.18%	21.43%	23.21%	13.39%
Lack of external funds for such activity	22.32%	19.64%	25.89%	16.96%	15.18%

Figure 15. External limitations as responded by SMEs in Hungary
Source: Author's

Again, evaluating the responses by SMEs with different age, size and dominating economic sector, no significant opinion was found by age and dominating sector. The only significant different could be detected in case of external funds ($F=3.426$, $p=0.036$), namely SMEs working in the production and trade sector rather find it a problem than SMEs in the service sector ($MEAN_{service}<3$).

4.4. Regulatory bodies' pressure on digitalisation

SMEs working in different sector or with different size find various limitations important for their business operations as for example the lack of external funds. Regulatory bodies on the other hand might support SMEs to increase the rate and levele of digitalisation. What SMEs think about the regulatory pressure was surveyed as well in three questions. Table 13 reflects that SMEs do not find serious pressure on digitalisation from the regulatory bodies regarding repscriptions, expectations or even actual pressure, each question was rather disagreed by the SMEs, however, it must be noted that the highest number of responses came for the 'neutral' response.

Table 13. SME opinion on regulatory bodies' behaviour

Regulations	Mean	Median	Mode	SD	IQR
The regulatory bodies prescribe that the company should be more digitalised.	**2.58**	3	**3**	1.220	3
The regulatory bodies expect that the company should be more digitalised.	2.69	3	3	1.302	3
In general, there is a regulatory pressure for the company to be more digitalisation.	2.86	3	3	1.413	2

Source: Author's

Figure 16 shows that over 40% of the particiapting SMEs are satisfied with how regulatory bodies behave regarding improved digitalisation. However, slight differences could be detected and while SMEs feel the least that digitalisation is prescribed (25%), more feel expectations (28.5%) and even more expeerience pressure to be more digitalised (33.04%).

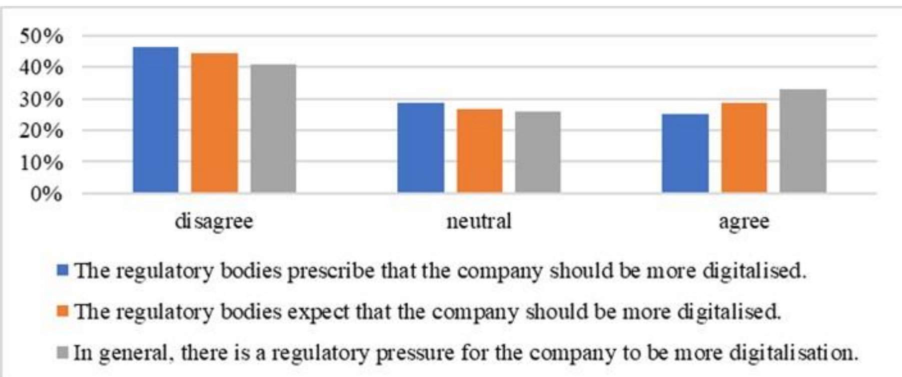


Figure 16. Distribution of responses by SMEs on regulatory bodies' behaviour

Source: Author's

Companies are of similar opinion about regulations regardless of their age and the main economic sector. However, along the size of companies a significant difference was detected again between micro- and small-sized SMEs (see Table 14). Medium-sized SMEs are of the opinion that the regulatory bodies prescribe a higher rate of digitalisation ($MEAN_{10\text{-}49}$>3), while non significantly small - and medium-sized SMEs feel the expectations and significantly differently the pressure is rather small- and medium-sized SMEs and not on micro-SMEs.

Table 14. Significant differences of opinions about digitalisation by company size regarding regulatory expectations.

Expectations by the regulatory bodies	F	Sig.	Levene test	Sig.
The regulatory bodies prescribe that the company should be more digitalised.	4.528	**0.013**	1.496	0.229
The regulatory bodies expect that the company should be more digitalised.	2.857	0.062	1.028	0.361
In general, there is a regulatory pressure for the company to be more digitalisation.	3.122	**0.048**	3.329	0.040

Source: Author's

5. DISCUSSION AND SUMMARY

The basic aim of the research is to identify the reasons for the emerging lag of Hungarian SMEs on the basis of the Digital Economy and Society Index (European Commission, 2021). The implications for the research questions are as follows.

RQ1: Is there a pressure on SMEs in Hungary from the regulatory bodies to reach a higher level of digitalisation or SMEs are ambitious to digitalise their processes to a greater extent? To what extent do SMEs use different software, how well do they exploit the potential of social media?

In order to boost digitalisation of business processes the focus must be put on SMEs which do not believe that digitalisation is beneficial to the business processes, or it does not give added value in company performance. Regulatory bodies need to support these SMEs, finding their needs being with demand for better connectivity, or offering trainings or financial support or providing flexible and guided digital investment schemes and programmes. The participating SMEs do not feel a pressure from the regulatory bodies regarding prescription or expectations or even pressure to be more digitalised, however, the high number of 'neutral' responses might indicate that either SMEs do not wish to digitalise more or satisfied with the rate of digitalisation.

If it is considered that SMEs contribute to the Hungarian GDP in 45% (Hungarian Central Statistical Office, 2020) it is important to have a clear view of their digitalisation performance. To this end, it is essential to have methodologies available to assess with confidence their current state of digital maturity and to see the steps that will ensure progress. These methodologies are available but not well understood by entrepreneurs and their practical application is below expectations.

The knowledge on the possible digitalisation in business processes mean a significant limitation to medium-sized companies which might pair with the problem of human resource limitations. SMEs operating in the production sector has human resources problems while SMEs operating in the service industry manage to take on employees with good skills and training.

RQ2: To what extent do SMEs use different software, how well do they exploit the potential of social media?

The findings in terms of software and social media usage clearly confirm the preliminary expectations, so it is no coincidence that Hungary is second to last in the EU ranking in in terms of business digitalisation (Éltető, 2021). The 50% software usage seems very low, even if we assume that business owners and managers may not have taken some software into account in their answers. Considering that the integration of social media platforms into business processes is almost essential for the digitalisation of sales and marketing, the percentage of SMEs that have recognised this opportunity is worryingly low.

RQ3: Do SMEs with different size, age and in different economic sectors find similar benefits of digitalisation?

The benefits of digitalisation are known and recognised by SME owners and managers in the light of their responses. All of the benefits identified by several researchers (Salvi, Vitolla, Rubino, Giakoumelou, & Raimo, 2021; Marcysiak & Pleskacz, 2021) were considered important and relevant by respondents. The evaluations assigned to each digitisation benefit varied according to the size of the enterprise. This confirms the duality identified by Máté (2020), whereby firms value and intend to exploit the potential of digitalisation differently depending on their size. This suggests that some micro-enterprises might be definitively left behind if they are not adequately informed and trained to change their attitudes. (Csigó, Dobos, & Nemeslaki, 2021)

Since a large proportion of the responding SMEs found digitalisation beneficial to business during the COVID-19 pandemic, they are assumed to further invest in digitalisation if the internal and external limitations can be reduced. Further digitalisation could help these SMEs to become digitally mature and step forward on the digital maturity ladder and, as such become either adaptors or even windfallers in the future.

RQ4: Do SMEs with different size, age and in different economic sectors find similar limitations of digitalisation?

The research can conclude that even if SMEs has the motivation, knowledge and the adequate leadership to boost digitalisation the lack of well-defined strategy, lack of finance and resources put the greatest barrier against digitalisation. Furthermore, the SMEs who could not decide for or against, need more information to encourage them to digitalise further their business processes and give administrative or coaching support to explore what specific limitations occur at their company. SMEs proved that their leadership is devoted to digitalisation since the highest number of SMEs disagreed that the lack of leadership would hinder digitalisation.

SMEs do not meet serious external limitations such as power supply, internet accessibility, experiences service providers or external funds, however, as the responses reflected SMEs might face internet access and connectivity problems, or they do not find adequate service providers. SMEs are satisfied with the external funds available, even if SMEs in the production and trade sector would rather require external funds than SMEs in the service sector.

Perhaps the most important question is why more energy is not being invested in catching up. Business leaders did not really highlight any factors that would really hinder digital transformation, nor did they identify any external pressures that would encourage them to develop and innovate. The DESI result suggests, however, that the digital ecosystem (Sussan & Acs, 2017; Szerb, Komlósi, & Páger, 2020) (infrastructure, supportive environment) is fundamentally given for transformation. At the same time, the fact that respondents do not adequately assess their own management constraints raises serious questions about the entrepreneurial ecosystem. An important dimension of digital maturity is the human dimension (North, Aramburu, Lorenzo, & Zubillaga, 2019; Schallmo, Lang, Hasler, Ehmig-Klassen, & Williams, 2021) that considers different organizational and cultural aspects such as an encouraging “leadership” and vision towards digitalisation. As long as managers do not see their own limitations in this area, no shift in the speed of digital transformation can be expected.

Therefore, in order to improve digital maturity, the authors argue that the primary task is to strengthen the entrepreneurial culture, to shape the entrepreneurial mind-set within and to strengthen SMEs' capacity to manage human resources and to encourage SMEs' participation in training programmes.

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Possibilities and barriers for Industry 4.0 implementation in SMEs in V4 countries and Serbia

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DIGITALISATION OF PAYMENT SERVICES IN THE SMEs SECTOR IN POLAND

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Abstract

The SME sector plays a key role in the Polish economy. The functioning and development of the SMEs sector, regardless of the type of business, is determined by ubiquitous digitalisation. This is based on electronic communication, digital technologies, the virtualisation of activities and the interweaving of digital reality with the real world. As a result, there are many opportunities and threats that affect the conditions under which SMEs function. Therefore, in the current economic reality, the results and development opportunities of any enterprise are largely determined by innovative projects that adapt the behaviour of enterprises to the requirements of the market and digital economy. These pose challenges for the enterprise, among others in the area of payment services, which the SME sector must overcome in order to develop and meet the needs of its stakeholders. Digitalisation is a natural consequence of technological development and the changing preferences of SME partners, and this change in preferences also applies to payment services. The objective of this paper is to identify key developments related to digitalisation in the field of payment services in the SME sector in Poland. The most frequently selected payment method by small and medium-sized enterprises is bank transfer, while in micro-enterprises the most frequently used payment method is cash (42%). Given the dynamic development of non-cash transactions in Poland, it may be expected that in the future, SMEs which offer cash-only payments may decline

in popularity. Taking into account the possibility for SMEs to increase their number of customers, improve their competitiveness and increase the security of monetary transactions, it is expected that interest in the SME sector in diverse forms of digital payments will increase in the future, and that the market share of these payments will rise.

Keywords: *SME sector, Digitalisation, Payment services*

1. INTRODUCTION

Most businesses around the world can be classified as small and medium-sized enterprises (SMEs). They play a key role in providing livelihoods and incomes for households, in creating new jobs, in supporting added value, and in the economic development of a country. Moreover, SMEs are associated with innovation and enhanced productivity, as well as economic diversification, integration and social cohesion (OECD, 2017). The enterprise sector is an important branch of the Polish economy as it generates nearly three quarters of Polish GDP, of which almost half (49.9%) is generated by small and medium-sized companies. This means that the potential for development is high, but entrepreneurs need support in reducing barriers to their business. Most of them are aware of the opportunities that digitalisation can bring to their business. Digitalisation is the process of transforming a company's assets into new sources of revenue and growth and covers other operational results that add value to the enterprise by exploiting the opportunities offered by digital technologies. Besides, digitalisation enables the development of new business models that evoke unique customer experiences by offering new products and services, as well as using the company's resources in a much more efficient way due to new combinations of information, human capital and the technological resources of the company (Łobejko, 2018).

Digitalisation is also understood as activities using digital tools that aim to increase productivity and accelerate economic growth. Digitalisation contributes to productivity growth in the following ways: through process optimization, market expansion, innovative products

and more efficient use of human capital (McKinsey & Company, 2016). Digitalisation affects the activities of SMEs as they can maintain their existing activities by expanding their sales markets, giving them the tools to attract new customers, while at the same time affecting their competitiveness. Therefore, SMEs need digital capabilities and tools as these are essential for managing an increasing variety of data and performing analyses for decision-making purposes. Moreover, new business support tools are nowadays exclusively digital in nature, which means that companies need to familiarise themselves with digital solutions, as over time they will not be able to communicate seamlessly and effectively with their partners (Orłowska and Żołądkiewicz, 2018; Paiola, 2018). Digitalisation is a natural consequence of technological development and the changing preferences of SME partners, and this change in preferences also applies to payment services.
The aim of the study is to identify key transformations related to digitalisation in the field of payment services in the small and medium-sized enterprise sector (SME's) in Poland. The following research methods were used in the study: in the theoretical part - a critical analysis of the source literature, and in the empirical part – desk research analysis (so-called existing data analysis). The considerations undertaken fall within the scope of economic sciences in the discipline of finance, with particular emphasis on sub-disciplines such as banking, international finance and payment services. The subject matter covers current problems of contemporary finance, also from the perspective of dilemmas related to the development of the financial sciences.

2. PAYMENT SERVICES IN POLAND IN THE AGE OF DIGITALISATION

2.1. The essence of payment services vs digitalisation

Payment services are classified as financial services that are of fundamental importance to the economy, enterprises and consumers.

For entities in the SME sector, they are the basis for building relationships with the environment and above all with customers. They ensure the efficient functioning of companies and allow for faster access to funds, as well as easier, cheaper and faster settlement of liabilities. The pace and variety of changes on the payment services market, above all digitalisation, have influenced the behaviour of entities from the SME sector. Modern information and telecommunication technologies have enabled innovations to emerge in payment services and have contributed to increased efficiency and security and lower payment processing costs. The widespread availability of mobile communication devices, e.g., mobile phones, smartphones, or notebooks, as well as their rapidly developing functionality, has contributed to an increase in demand for services offered via them (Klimontowicz, 2013).

In Poland, there is no definition of payment services in legal regulations, especially in the Act on payment services, there is only a closed catalogue of specific types of activity that should be treated as payment services. Payment services shall mean activities consisting of:

1. acceptance of cash deposits into and making cash withdrawals from a payment account and any operations required for account maintenance;
2. execution of payment transactions, including transfer of funds to a payment account with the user's provider or another provider:
   - by executing direct debits, including one-off direct debits,
   - by using a payment card or a similar payment instrument,
   - by executing transfer order services, including standing orders;
3. execution of the payment transactions listed in point 2, where the funds made available to the user derive from credit, and in the case of a payment institution or an electronic money institution – from credit
4. issuance of payment instruments;
5. enabling acceptance of payment instruments and execution of payment transactions initiated by a trader or through them, using a payer's payment instrument, in particular involving handling

authorisations, transfer to the payment instrument issuer or payment systems of payment orders of the payer or the trader in order to transfer funds owed to the trader, with the exception of activities involving its accounting and settlement within a payment system, within the meaning of the Act on Finality of Settlement (acquiring);

6. provision of money remittance services;
7. provision of payment initiation services;
8. provision of account information services. (Financial services bill, art. 3.1).

The process of digitalisation in payment services contributes to technological innovation, which in the financial sector is identified by the term FinTech (financial technologies), which is ambiguous, often discretionary and still evolving. The Financial Stability Board (FSB) defines FinTech as technological innovations in financial services that shape new business models, applications, processes or products, and which significantly affect the delivery of financial services (FSB, 2017). From the perspective of business entities, FinTech is a sector consisting of companies that base their operations and business model on modern technologies and ICT solutions that have the potential to transform the financial services sector. They create innovative products to meet the financial needs of their customers in a more efficient, friendly, transparent and automated way (NBP, 2020). One FinTech business segment is PayTech, i.e. the segment related to payments. PayTech includes companies that provide solutions, services or products for processing payments in the digital and physical world. The main areas in this field are contactless payment cards, mobile card payments, non-card mobile payments, instant payments systems, electronic money, as well as other PayTech initiatives, as shown in Figure 1. The PayTech sector can be divided up according to the functional model of the payment implementation process shown in Figure 2.

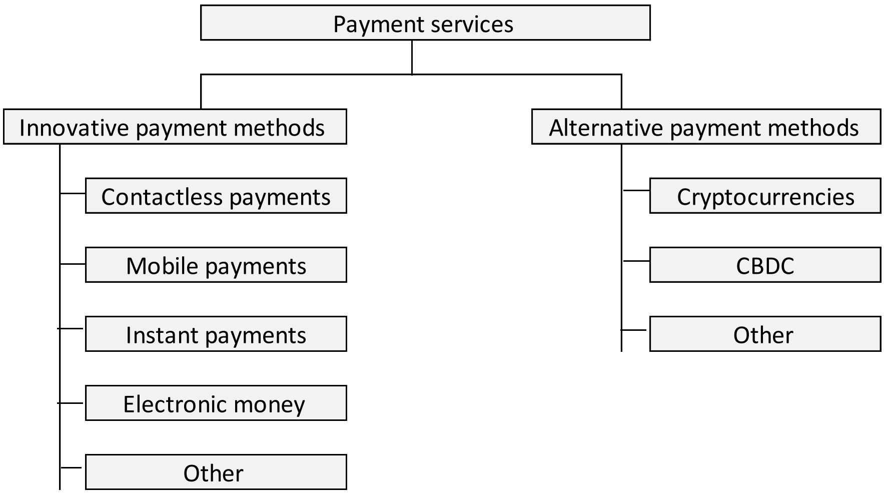

Figure 1. Classification of payment services within PayTech
Source: NBP (2020)

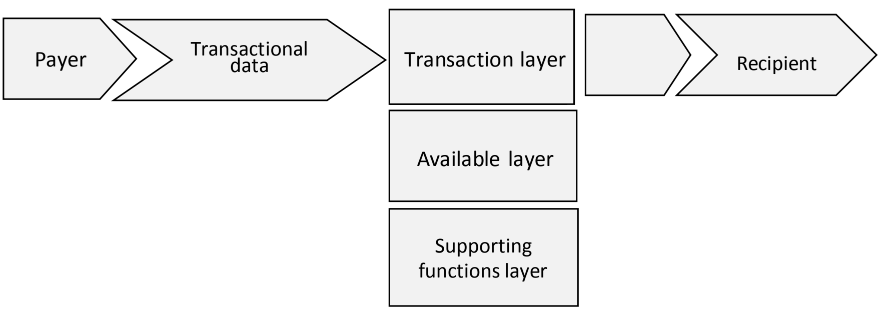

Figure 2. Functional payment processing model
Source: NBP (2020)

2.2. Credit transfers and direct debits as essential payment services in the age of digitalisation

A payment service is the execution of payment transactions (including the transfer of funds to a user's payment account with the same or

another provider). These types of service include credit transfers (including standing credit transfers and direct debits - also including one-off direct debits). A credit transfer is an instruction given to a bank by a debtor to debit his account by a specified amount and credit the creditor's account with that amount. The bank executes the debtor's instruction in the manner provided for in the bank account agreement (Banking Law, Art. 63c). A credit transfer order may be in traditional (paper) form or by e-transfer (electronic transfer). In the case of an electronic credit transfer (whether by telephone or over the Internet), various individual security features are verified in the form of one-time passwords, SMS codes, codes generated using tokens, etc.
Direct debit means a payment service consisting of debiting the payer’s payment account by a specified amount so as to effect a payment transaction initiated by the payee which is executed on the basis of consent extended by the payer to the payee, the payee’s provider or the payer's provider. (Financial services bill, art. 3.2). A direct debit is a payment service that is initiated by the payee. This initiation takes place on the basis of the payer's consent to debit their account. According to the definition, this consent can be given to the payee, to the payee's supplier or to the payer's supplier. In the case of a so-called SEPA Direct Debit, consent is given simultaneously to the payee (authorisation to initiate the transaction) and to the payer's payment service provider (a debit instruction based on information received from the payee). Consent can be given by the payer in writing or electronically (Grabowski, 2013). This service can also be made available through electronic banking. A modification to direct debit was introduced in 2018 in Poland, involving transactions between parties participating in QLIPS. The provider of the product or service posts real-time payment information in the payer's e-banking system in the Invoobill 2.0 database, and the payer approves the payment with a click, without having to enter liability information or the provider's data into the system. The above modifications to direct debit therefore allow the payer to accept the transaction, which removes their doubts about using this form of payment, as they can decide each time

whether to pay, for which they do not have to fill in forms (e.g., when making a bank transfer) (Milic-Czerniak, 2019).

Continuous technological development (including the digitalisation process) and the growing expectations of financial market participants in terms of acceleration of the payment process, have forced changes to be made, above all leading to the development of new settlement solutions, including instant payments, allowing for faster discharge of liabilities. Instant payment is an electronic payment solution available 24/7/365 (24 hours, 7 days per week, 365 days per year), resulting in immediate or almost immediate crediting of the payment recipient's account (regardless of the method/scheme used to settle this type of payment and the electronic payment instrument used to make it) (NBP, 2015). An example in Poland is the Express Elixir payment system operated by KIR S.A., which enables direct execution of domestic transfers in PLN without any time limits. The solution may only be used by customers (individuals and businesses) of banks that participate in Express Elixir which have signed a participation agreement with KIR and implemented technological solutions enabling exchange of payment messages through this system. The BlueCash payment system is the second instant payment system in Poland, operated by Blue Media S.A. It is a solution for transferring funds between the sender and the recipient in real time (using the 7/24/365 model). The system can be accessed from external pay-by-link websites (direct bank transfer) and by bank transfer from electronic banking (NBP, 2020).

A popular form - from the point of view of convenience of online payments - are instant electronic transfers, often referred to as pay-by-link payments. In this solution, when the user wants to make a payment on the Internet, they select a link to the bank in which they hold a bank account. After logging in, a ready-made payment form is displayed, containing the recipient's data and the transfer amount. The customer orders the transfer. Funds from the customer's account are transferred to the Internet payment aggregator's bank account held in the same bank as the customer's account. The transfer takes place

immediately, and the recipient is informed via SMS or e-mail that the payment has been credited to the aggregator's account. Within a few working days, the funds from the aggregator's account are transferred to the company's account.
Another type of fast payment under the name PayByNet, is offered by KIR S.A. It consists of enabling customers to make immediate transfers without the need to have an account at the same bank, and therefore without the need to use an intermediary (such as an Internet payment aggregator). After completing the transfer, information about the payment is sent immediately to the company, even before funds are credited to the shop's account. KIR provides payment guarantees for transfers ordered in this way (Grabowski, 2013).

2.3. Contactless and mobile payments

Contactless payments, a payment service that has become quite popular in the digital age, are either included in mobile payments or treated as a separate category of payments. According to the Committee on Payment and Settlement System - CPSS, operating at the Bank for International Settlements, contactless payment refers to proximity cards and defines them as cards that do not require physical contact between the card and the reader/terminal (BIS, 2003).
A contactless payment is an electronic payment where the transfer of transaction data from the consumer's payment device to the trader’s POS terminal does not require physical contact between the devices (Harasim, 2013).
Contactless payments are performed through the use of technological solutions based on short-range wireless communication between the reader (trader) and the card or phone (customer) equipped with an appropriate communication module (Banaś, 2014). In these payments, the key role is played by short-range radio wave technology NFC (Near Field Communication), which uses the interaction of electromagnetic fields to transmit information over short distances (usually 4-10 cm). The following categories of contactless payments

are distinguished: payments using contactless cards; payments using mobile devices especially mobile proximity payments; payments where the carrier allowing proximity payments is placed on other consumer accessories (e.g. in a watch or a piece of clothing) or even under the consumer's skin (Harasim, 2013).

Mobile payments (m-payments) are defined as all payment operations made with mobile (portable) devices, such as mobile phones or PDAs (handheld computers). Due to the rapid development of information technologies and their applications, it can be expected that other devices will also be used for payment purposes (Klimontowicz, 2012). Mobile payments are where a mobile device (e.g. a mobile phone) is used to at least initiate a payment order and potentially also to transfer funds. The device in this case becomes an electronic payment tool that enables payments to be made anywhere. These transactions can be both at a traditional point of sale or executed remotely, e.g. using the Internet (e-commerce) (Klimontowicz, 2013). Taking into account the method of payment settlement, they are divided into:

- Pre-pay - the pre-pay value is stored in the mobile phone and during the transaction the amount due is deducted from it; settlement takes place via access carried out using a mobile device or a (pre-paid) card containing a code - its entry into the phone adds a certain value to the account to be used for purchases;
- Post-pay - consists of the value of individual transactions made by the customer in a certain period of time being recorded on their account, which only at the end of the billing period is debited to the appropriate amount; these are carried out using credit cards or a mobile network operator billing system (Klimontowicz, 2012).

The classification of mobile payments based on various criteria are presented in Table 1.

Table 15. Classification of mobile payments

Criteria	Mobile payments breakdown	
Payment settlement method	pre-pay (debit type)	m-wallet
		pre-paid card
	post-pay (credit type)	credit cards
		billing system
Type of technology	- remote - can be performed anywhere and at any time, ties the mobile device to the bank account - proximity - performed through a chip installed in the portable device on which account data is stored; a proximity terminal is needed to perform the transaction	
Payment size	- micro-payments that do not exceed EUR 1 (USD 2) - mini-payments that cover transactions between EUR 1 and 10 (USD 3 to 20) - macro payments for transactions above EUR 10 (USD 20)	
Place of transaction	- rPOS (realPoint-of-Sale), i.e. payments made at a traditional (real) point of sale, - vPOS (virtual Point-of-Sale), i.e. payments made at a virtual point of sale (transactions concluded via the Internet: e-commerce, m-commerce), also known as online payments, - P2P (person-to-person), i.e. payments between users, often used in online auctions	

Source: Klimontowicz (2013)

With regard to the parties to the transaction, the following can be distinguished:

- transactions between entrepreneurs, business entities (B2B - business to business);
- transactions between natural persons (P2P - person to person)
- transactions between business entities and customers (type B2C - business to customer), including transactions with the use of self-service devices (type C2M - customer to machine) (Koleśnik, 2016).

The most popular among non-card mobile payments operating in Poland is the mobile payment system and the BLIK payment scheme, which is operated by the Polish Payments Standard (PSP). This allows its users to make, among others: online payments, payments from POS terminals, cash withdrawals at ATMs and mobile P2P payments. BLIK is based on a unique 6-digit code which is generated by the payment application and displayed on the user's phone screen. The code received has to be entered at the payment terminal, in case of payment to a trader, and the use of the code is confirmed in the mobile application (NBP, 2020).

BLIK can also be used to pay in online shops. Another service is recurring payments. They are used to regulate cyclical and repetitive obligations whose amount is fixed. Payments made in this way do not require confirmation every time in the mobile application. An feature offered by the BLIK system is the possibility to make transfers to a phone number. Entities between which this transaction is to be made must first enable the ‘BLIK transfer to phone’ function in their banking application. Transfers made in this way reach the recipient immediately, even if the persons making the transaction may have bank accounts in two different banks. BLIK transfers to a phone number are also available if the recipient has a bank account with a European bank. This is possible thanks to the Polish Payments Standard joining the Standardised Proxy Lookup programme. The BLIK system also offers BLIK cheques, consisting of nine digits. They allow withdrawals from ATMs and the making of payments at traditional payment points up to a predefined amount (Błach, Klimontowicz, 2021).

2.4. Other payment services in the age of digitalisation

In the context of using the Internet to provide payment services, virtual card services are worth noting in particular. A virtual payment card has no material form, but is merely a digital record. These cards are a 'virtual purse' that can be reloaded several times. The bank does not therefore give you a physical card, but only the data you need to pay online: card number, expiry date and CVV2/CVC2 code. Such a card can be used to make transactions up to the amount of funds previously deposited in a specially created account to which the card has been issued. The virtual card can be repeatedly 'topped up' with funds up to the amount of the limit set on the card (Wójcicka, 2015).

Another service related to the provision of payment services is the so-called Internet payment aggregation service, which consists of enabling one service provider to use multiple payment methods. Standard methods include: bank transfer, the so-called fast bank transfer; payment by credit card; payment by SMS-premium; and payment by Internet vouchers. Such a service provider subcontracts with entities providing services or selling goods via the Internet. Such entities are offered a secure and multifunctional service for accepting payments for goods and services. In return, they pay fees to the service provider in the form of commission or a subscription. The buyer makes the payment outside the trader's website, which has an impact on the security of the transaction. It also remains anonymous for the seller (Grabowski, 2013).

Deferred payments have also appeared as a payment service on the Polish market and are gaining in popularity. They consist of the possibility to make online purchases of products or services with payment up to 45 days from the order date. During this time, the customer has the opportunity to return the goods free of charge (in accordance with the regulations of the shop), and after the expiry of this period the payment can be spread over instalments. Deferred payments are provided both by companies with long experience in payment services (e.g. PayU),as well as by new PayTech companies such as e.g. Allegro Pay, which enter the market as independent operators in this area or in cooperation with already existing entities (NBP, 2020).

Another payment service is the use of an escrow account to make online payments. The principle of escrow is that the payer deposits certain funds into a bank account, with the proviso that the funds will be forwarded to the payee once certain conditions are met. An escrow account used in online payments is a tripartite agreement between the buyer, the seller and the intermediary - the payment service. The buyer and seller agree on the terms of the transaction and the use of escrow

as a means of payment. The buyer opens an escrow account and determines the payment amount. Information about the opening of the account and the amount is received by the seller, who approves this data. The buyer then makes the payment into the escrow account. The funds are blocked for both the seller and the buyer. The seller receives confirmation that the funds have been blocked, and sends the goods or performs another service for the buyer. After receiving the service, the buyer checks its compliance with the agreed terms and conditions. In the case of positive verification, they accept the fulfilment of the obligation by the issuer through the Internet system (Polasik, Maciejewski, 2009).
Another example of payment services are loyalty cards (so-called prepaid vouchers), which consist of a number and information about its value. These can be in both paper and electronic form (for example, they are sent to the user by e-mail). Payment is made by entering the number in the seller's payment form and entering the value of the payment to be made (Grabowski, 2013).

3. THE SME SECTOR IN POLAND

3.1. Characteristics of the SME sector

According to current European Union law, the SME sector is defined on the basis of quantitative criteria which are directly linked to the number of employees (fewer than 250) and the size of turnover (not exceeding EUR 50 million) and the balance sheet total (not exceeding EUR 43 million). The SME sector is not a homogenous category, since within this sector a distinction is made between micro, small and medium-sized enterprises (Table 16).

Table 16. The structure of SMEs

Enterprise size	Number of employees	Annual turnover	Annual balance sheet total
Micro	1-9	≤ EUR 2 million	≤ EUR 2 million
Small	10-49	≤ EUR 10 million	≤ EUR 10 million
Medium	20-249	≤ EUR 50 million	≤ EUR 43 million

Sources: European Union (2014), ANNEX I, Article 2

In 2020, there were over 2262 enterprises in the enterprise sector in Poland, of which over 99.00% were SMEs (Figure 3).

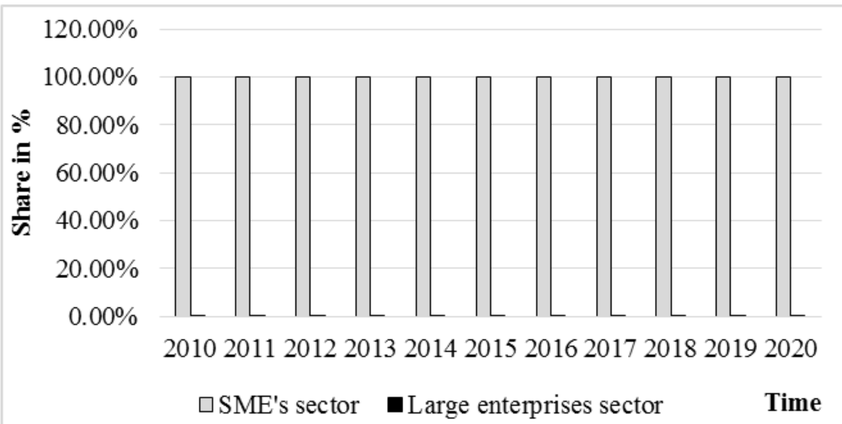

Figure 3. Structure of enterprises in Poland (2010-2020)
Source: Statistics Poland (GUS)

As Figure 1 shows, the enterprise sector in Poland has been dominated by SMEs since 2010. Among them, micro enterprises constitute the largest percentage of SMEs. Over the period in question, the number of micro enterprises is on a sustained upward trend, while the number of small and medium-sized enterprises is slightly decreasing (Figure 4).

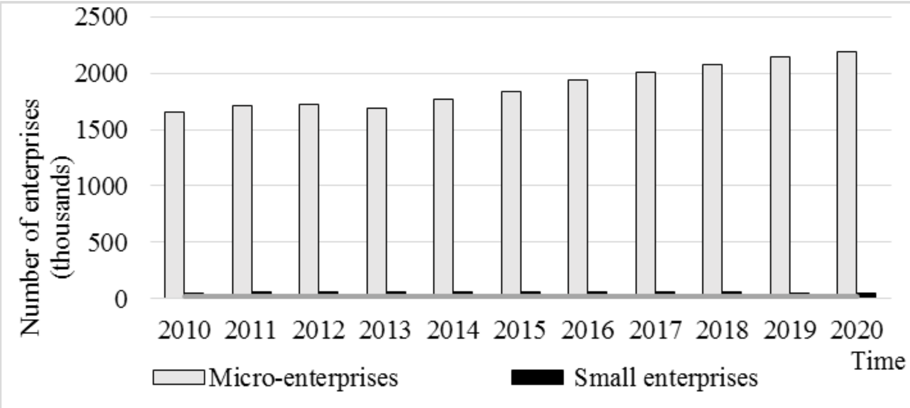

Figure 4. Structure of SMEs in Poland (2010-2020)
Source: Statistics Poland (GUS)

Since 2010, the number of micro enterprises has increased year-on-year by on average 57.3 enterprises. This is confirmed by the mathematical trend analysis, on the basis of which trends in the SME sector in Poland were determined:

- micro enterprises: Y = 57.3 x + 1542;
- small enterprises: Y = - 0.58 x + 58.15;
- medium-sized enterprises: Y = - 0.11 x + 15.98.

SMEs show the highest activity in the service industry and in trade (in services and trade), and the lowest in construction and industry (Figure 5). The dominant services provided by SMEs are professional and scientific activities, and technical services, health care and social assistance (Figure 6).

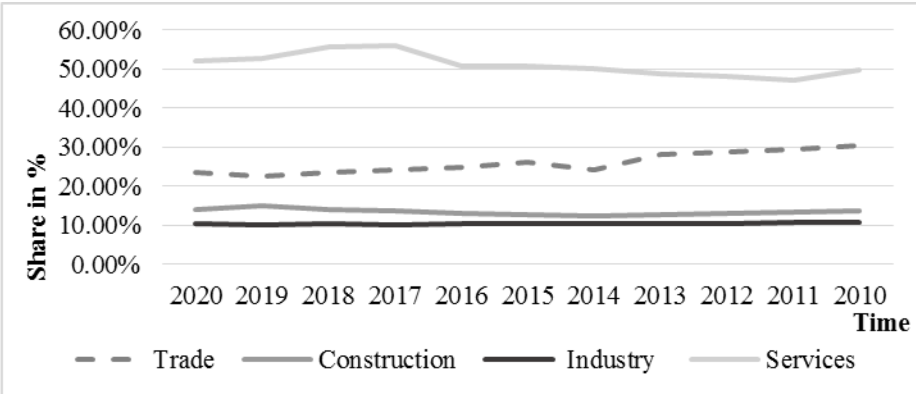

Figure 5. The structure of SMEs in Poland according to the principal area of activity
Source: Statistics Poland (GUS)

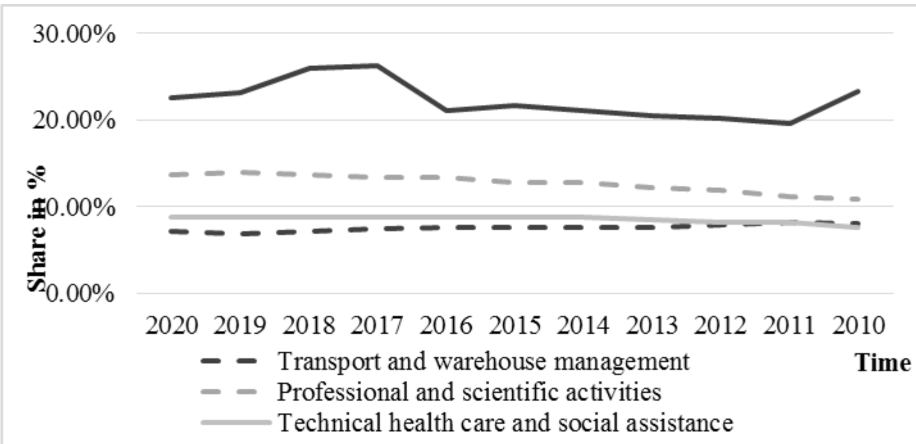

Figure 6. The structure of the service activity of SMEs in Poland
Source: Statistics Poland (GUS)

The dominant legal form in the SME sector in Poland is natural persons. In 2020, as many as 87.5% of enterprises were natural persons, and only 12.5% were legal persons and entities without legal personality.

3.2. The level of access to e-banking among SME's

The level access to e-banking among SMEs in Poland is analysed in two dimensions:

- Number of SME users with access to electronic banking;
- Number of active SME electronic banking users.

Since Q1 2010, both the number of SMEs with access to e-banking and the number of active SMEs with access to e-banking has increased significantly. In the period studied (from 2010 to 2020), the number of e-banking users increased by 104.39%, while the number of active e-banking users increased by 115.74% (Figure 7).

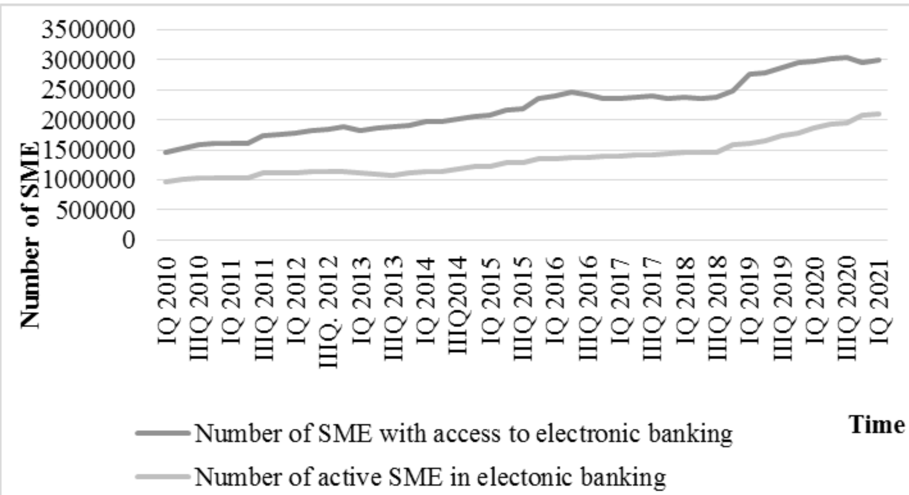

Figure 7. SMEs with access to electronic banking (2010-2020)
Source: The Polish Bank Association (ZBP)

Along with the increase in SME access to e-banking, there was also an increase in the average value of an SME transfer by 67.74% and an increase in the average value of settlements per one active SME by 68.52% (Figure 8).

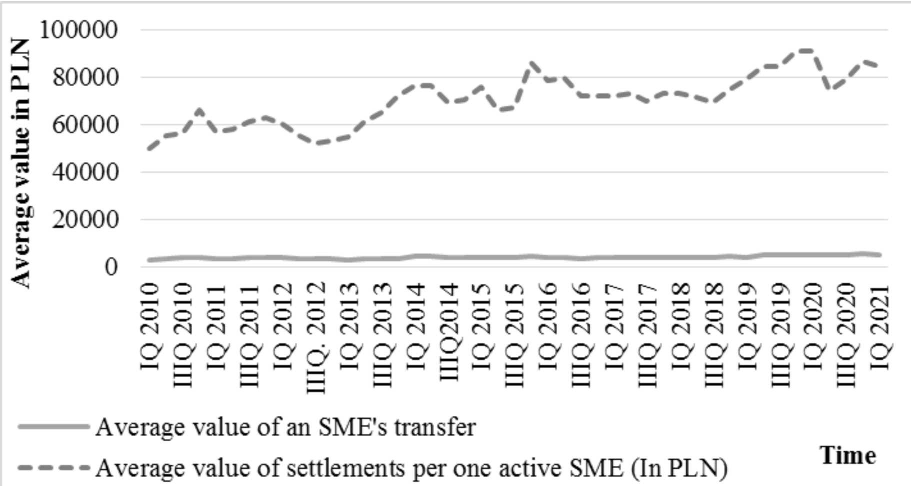

Figure 8. Average value of an SME transfer and settlements (2010-2020)

Source: The Polish Bank Association (ZBP)

This form of payment is used by 84% of SMEs (Elavon, 2019). However, the increase in access to e-banking in the SME sector is contributing to the growth of digital payments in this sector. In 2019, Elavon conducted a survey among SMEs on payment methods made available to customers. The report found that most SMEs make card payments available, with 51% of businesses honouring credit cards, and 48% accepting debit card payments. A large percentage of SMEs allow their customers to pay by bank transfer. The high proportion of payments using innovative mobile payment methods such as BLIK, Apple Pay or Google Pay, as well as payments by phone, should also be borne in mind. This shows that SMEs are flexible and open to innovative payment methods and can adapt to prevailing trends and the changing needs of their customers (Figure 9).

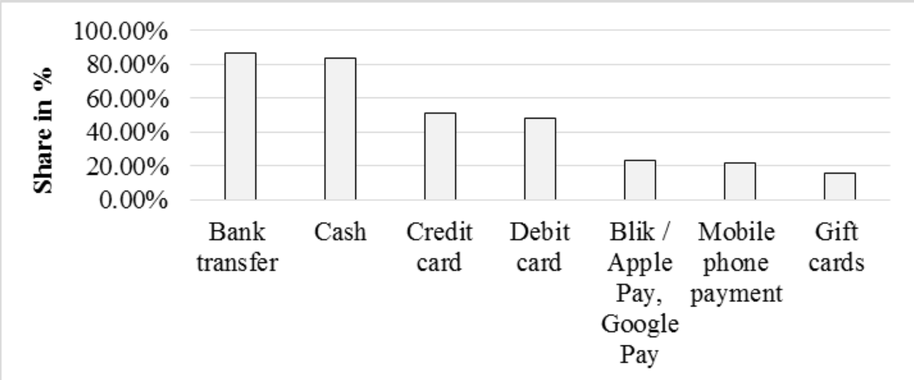

Figure 9. Payment methods made available to customers
Source: Elavon (2019)

With access to e-banking, SMEs gain the ability to offer additional payment methods to their customers. This is particularly important due to the growing popularity of payment services in Poland. The study has shown that Poles are increasingly willing to use digital payment solutions, and that the level of use of digital payments is increasing (Figure 10).

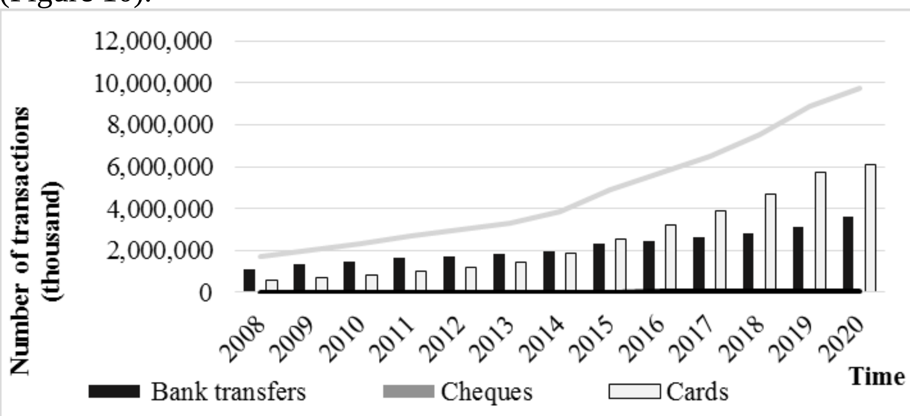

Figure 10. Number of non-cash transactions in Poland (2008-2020)
Source: Elavon (2019)

As Figure 8 shows, in the years 2008-2013, the dominant form of payment in Poland was bank transfer. However, the high utility of payment cards and the development of digital payments (e.g. contactless payments) contributed to a significant increase in card payments. Since 2015, the share of payment cards in digital payments has doubled, and in 2020 it amounted to 62.7%. A reverse tendency is observed in the case of other payment methods, as shown in Figure. Although the number of payments using bank transfers and direct debit is systematically increasing, the share of these payment methods in total digital payments is decreasing.

The change in payment trends in Poland is an opportunity for SMEs to increase their turnover, especially in the light of the dynamic development of e-commerce. The growing popularity of digital payments is forcing SMEs to adapt to customer needs, but at the same time, it is improving the security of money transactions for SMEs, and contributes to an increase in the competitiveness of SMEs. Therefore, it is expected that in the near future there will be an increase in innovative payment methods made available to SME customers, especially BLIK, Apple Pay and Google Pay.

3.3. Barriers to the development of digital payment services in SMEs in Poland

The biggest challenge for SMEs concerning the payment options offered to SME customers is the need to keep up with technological change. This barrier is declared by more than 35% of SMEs (Elavon, 2019). Meanwhile, 28% of SME companies indicate that one of the main difficulties of introducing new payment solutions is the need for investment. The barrier mentioned by the lowest number of companies (14%) is the lack of knowledge about what payment options they can offer customers and what payment options are available to businesses (Figure 11).

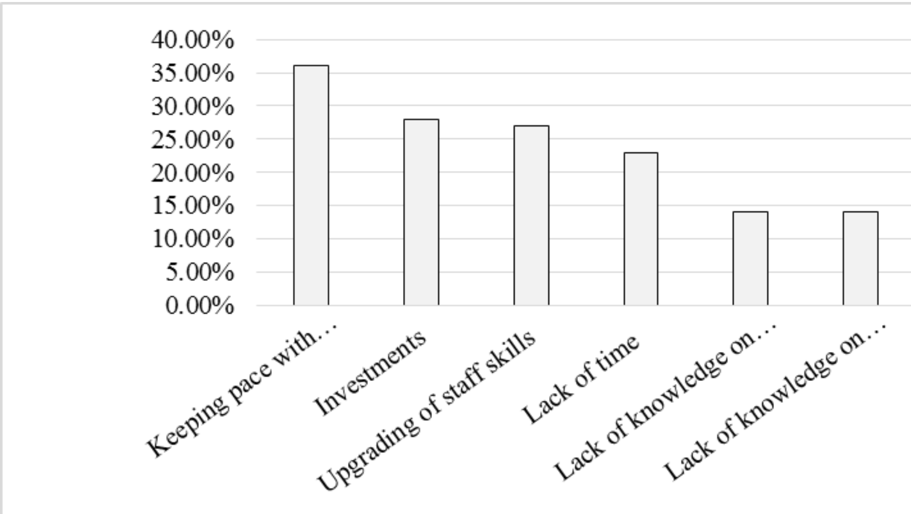

Figure 11. Challenges for SMEs regarding payment options offered to SME customers
Source: Elavon (2019)

The most surprising aspect of the data is that among other constraints related to the introduction of new forms of payment in SMEs, entrepreneurs indicate the need to increase staff qualifications and the lack of time for introducing a new payment solution. Entrepreneurs understand that the introduction of digital payment solutions increases competitiveness, as well as boosting the number of customers and increasing control over finances (Elavon, 2019), yet they do not find the time to make the necessary changes and avoid training staff in handling cashless payments.
An unquestionable obstacle to increasing the level of digitalisation of payments in SMEs is the increase in the cost of banking services. Over the past five years, the cost of bank accounts for SMEs has increased significantly, which may result in a reduction in their number and, consequently, a reduction in the possibility for SME customers to use digital payments (Figure 12).

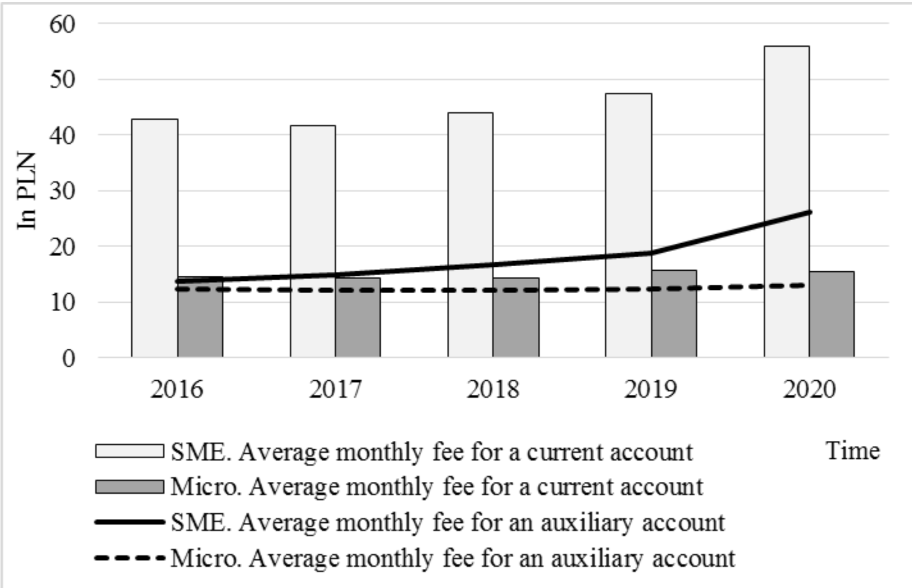

Figure 12. Average monthly bank account fee for SMEs (2016-2020)
Source: National Bank of Poland

In addition to an increase in the cost of bank accounts, SMEs also observe an increase in the cost of banking services, both at bank branches and over the phone and Internet. A reduction of the fee for both micro enterprises and SMEs was observed only in the case of execution of a standing order in a branch, but the usefulness of this service for SMEs seems to be low (Figure 13 and 14).

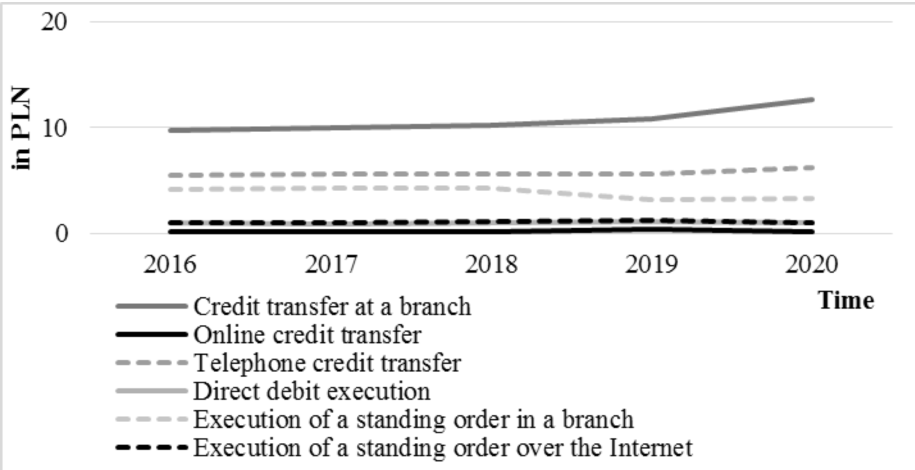

Figure 13. Bank charges and commission for micro enterprises (2016-2020)

Source: National Bank of Poland

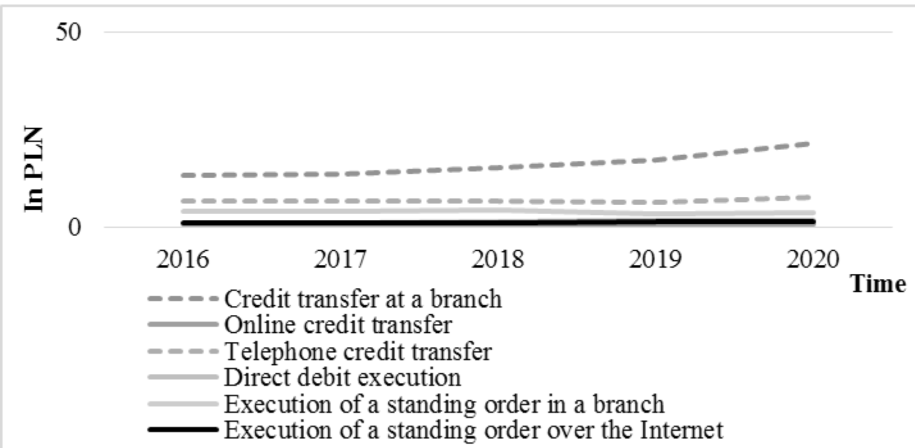

Figure 14. Bank charges and commission for SMEs (2016-2020)

Source: National Bank of Poland

The relatively high monthly fees associated with the use of a debit card should also be indicated as a barrier to the development of digital payments among SMEs in Poland. In the period under study, the average monthly fee for micro enterprises was PLN 5.16, and for SMEs PLN 4.07. It should be noted, however, that this fee increased significantly in 2020 for SMEs by 32.53% compared to 2019 (from PLN 4.15 to PLN 5.15). In the case of micro businesses, the monthly debit card fee decreased slightly from PLN 5.33 to PLN 5.17 (decrease by 3%) (Figure 15).

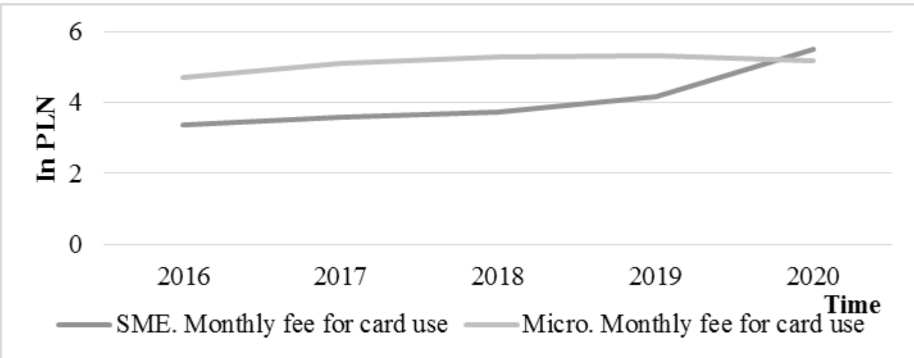

Figure 15. Monthly fee for card use for SMEs and micro enterprises (2016-2020)

Source: National Bank of Poland

Undoubtedly, the increase in banking service costs and the need to incur investment expenditure related to the development of digital payment infrastructure and employee training in this area is a factor that hinders the introduction of innovative forms of payment in SMEs in Poland. However, changing customer payment preferences and new retail trends (e.g. the development of e-commerce) are forcing SMEs to make the necessary changes. On the other hand, diversification of the forms of payment offered by SMEs to their customers is an opportunity for SMEs to develop. Due to the possibility of increasing the number of customers, improving the competitiveness of SMEs and increasing the security of money circulation in SMEs, it is expected that interest in this sector in diversified forms of digital payments will increase, and that the share of digital payments in this market will grow in the future.

4. CONCLUSION

Digitalisation contributes to optimizing the processes of entering new markets and expanding existing ones through the implementation ofnew and innovative products by SMEs. Thus, digitalisation nowadays has become the most effective tool for streamlining business processes in SMEs, and above all, it has enabled the opening up of the use of electronic payment services. In this sector, the use of the Internet or other digital technologies for settlement transactions is two-way, as both receiving and sending of financial payments are possible through electronic networks. According to research by Philip (2020), it can be concluded that there are two main reasons for the introduction of electronic payment services. One is a market determinant related to the increasing level of customer interest in the use of these forms of payment in direct transactions. The second, which is the result of a company's environment, is the readiness of companies in the SME sector to change their strategy towards being modern and innovative,. The barrier to using these services is not the costs of implementation and maintaining the required tools, but more importantly it is being convinced of the payment functionality based on empirical verification that the use of these forms of payment increases the level of sales (Filip, 2020).The fundamental problem in the digitalisation of payment services is regulation. Regulators need to strike a balance between ensuring market integrity and stability, and providing enough room for continuity, competition, innovation and rapid growth. This includes areas related to privacy protection, ensuring cyber security, combating illicit financial flows, money laundering and terrorist financing, and eliminating bad practices and exploitative financialization (Disse, Sommer, 2020). In addition, the concerns of customers and SMEs about the security of their transactions are an important issue, and one of the main barriers to adaptation that could limit the development of digital payment services. Moving the use of payment services to the electronic dimension also requires increased resilience to cyber-attacks of both online banking solutions and mobile applications. The virtualisation of payment services in the SME sector is also driven by the efficiency of systems and databases, as well as their availability, replication, synchronisation or diversification. This is in addition toa whole range of technological aspects related to IT solutions that require proper scaling to the business. The SME sector has significant growth potential for modern payment services, which lies in infrastructure resources and the growing awareness of upcoming changes. SMEs should therefore be financially, substantively and technically supported in their efforts to implement innovative electronic payment services in their business, which in turn will foster their digitalisation.

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THE EFFECTS OF FAMILIARITY OF INDUSTRY 4.0 TECHNOLOGIES ON BEHAVIOUR INTENTION OF SMEs IN SERBIA

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Abstract

Industry 4.0 is state-of-the-art technology that has increasingly gained a place in small and medium-sized enterprises. This study was carried out to explore the level of familiarity with technologies of Industry 4.0 among small and medium-sized enterprises in Serbia. Therefore, aiming at researching relationships among attitudes toward digitalisation, self-efficacy, and behaviour intention based on familiarity with technologies of Industry 4.0, the SEM approach was applied. Employing a developed structured questionnaire, out of 156 SMEs, a total of 134 respondents completed the questionnaire correctly. The findings revealed that familiarity with Industry 4.0 on the attitude towards digitalisation had positive effects, as well as attitude towards digitalisation on the behaviour intention positively affected. Therefore, the paper could supply achieving sustainable results in application technologies of Industry 4.0 in SMEs.
Keywords: *Industry 4.0, Technologies, Familiarity, Behaviour Intention, SMEs*

1. INTRODUCTION

A contemporary concept such as the Industrial Revolution has changed the economy and society. Rapid technological development has had a pivotal role in previous industrial revolutions. Moreover, the fourth industrial revolution (Industry 4.0) is expected to grow exponentially in the context of socio-economic impact and technical change (Zervoudi, 2020).

By focusing on digitalisation, Industry 4.0 supports technological innovations whose quantitative effects create new products, processes, production methods, and business models, which are strongly oriented towards the sustainable business of SMEs (Rakić et al., 2021; Riecken, 2000).

Nowadays, SMEs have been faced with the industrial processes of digitalisation and with technologies of Industry 4.0 that allow data interchange in real-time and increase speed, flexibility, productivity, and production quality (Yu & Schweisfurth, 2020). This indicates that the emerging technologies in the fourth industrial revolution have been promptly transformed the mode of life and work (Milošević et al., 2021). The increase in autonomy will require managers and employees to embrace new digital skills in order to adapt to new business conditions. The future of work belongs to those with emotional and social intelligence, who will consume more time solving creative and complex issues that machine automation is not adapted to deal with. In this light, technology knowledge and experience play an important role in accepting technologies (Venkatesh & Davis, 2000) that represent the abilities and skills using a technology (Buabeng-Andoh, 2012). Consequently, the technological literacy of SMEs explains the way managers and employees apply novelty technologies one their business in finding, organising, creating, and communicating information (Jamila et al., 2020; Agil, 2021).

Industry 4.0 strongly impact businesses by transforming the current economy and society using Industry 4.0 technologies (Bandholz, 2016). Therefore, SMEs should aspire to adapt to innovative changes and create new values and products in the Fourth Industrial Revolution. The technical implications of the Industry 4.0 have encouraged managers and employees to utilise a variety of Industry 4.0 technologies such as Cloud Computing, Internet of Things (IoT), Big Data, 3D printing and robotics, Virtual reality (VR), Augmented reality (AR), Autonomous Vehicles, Nanotechnology, Biotechnology, Materials science, Energy storage, and Quantum computation (Hahm, 2020; Wang et al., 2016; Klaus, 2016; Kim, 2014; Lee et al., 2014). Therefore, knowledge and utilising these skills are crucial to adjusting and generating business results.

In academic literature has been spotted on the lack which dealing with the level of understanding of various technologies in the framework Industry 4.0 in SMEs according to digital technologies aspect. Accordingly, the research aimed to examine relationships among attitudes toward digitalisation, self-efficacy, and behaviour intention based on familiarity with technologies of Industry 4.0 in SMEs in Serbia.

This research is vital because it enables understanding how SMEs could evolve more innovative. Furthermore, it may help managers of SMEs to create technology strategies in the light of the knowledge and implementation of new technologies that Industry 4.0 brings.

The paper has the following structure. Immediately after the first section of the Introduction, the following section refers to the theoretical background. Then, the third section studies the methodological aspects of the research. After that, the fourth section of the paper deals with the discussions of the main findings. In the last section, the conclusion of the study is given.

2. THEORETICAL BACKGROUND

The Fourth Industrial Revolution (Industry 4.0) is a logical follow-up to the previous industrial revolution. The very concept of Industry 4.0 dates back to the beginning of the second decade of the 21st century. The visionary idea was that industrial production could serve as a way of interconnection at a higher global level through the transformations for which Information and Communication Technologies is responsible (Saeedi et al., 2020; Muller et al., 2018).

Industry 4.0 relates to the emergence and development of many new technologies. These new industrial technologies refer to implanted sensors through which smart products and devices can communicate smoothly (Internet of Things); collecting and storing large amounts of data in real-time in order to optimise the quality of production and the costs (Big Data and Analytics); advanced manufacturing techniques, such as manufacture supplement (3D printing); artificial intelligence (AI); robots with greater flexibility; vertical and horizontal integration, etc. (Strange, & Zucchella, 2017; Rüβmann et al., 2015; Kagermann et al., 2013).

Many scientists claim that the Fourth Industrial Revolution is seriously threatening to transform into almost untouchable business models based on the isolated optimisation of individual activities within the company's value chain. They also argue that in the future, it can be expected greater and even complete integration and automation of business activities through the use of new technologies and methods of data collection and analysis (Klaus, 2016; Lee & Lapira 2013).

Porter and Heppelmann (2014) pointed out how Industry 4.0 will dramatically change connected products and how organisations work. According to Hamada (2019). A the technologies of Industry 4.0 enable products to be integrated. Automation and digitisation processes reduce human effort, improve business management efficiency, and lower the cost of products and services. In addition, the McKinsey Global Institute reports that 50% of companies believe that automation will reduce their number of full-time employees and that by 2030, robots will replace 800 million workers worldwide. As alarming as this data may be scary, a new wave of the industrial revolution represents a change within the workforce and the need for employees to adjust their skill set to take on more valuable roles (McKinsey, 2021).

In order to achieve the behaviour intention in the use of Industry 4.0 concepts, it is necessary to consider how much managers at the organisational level are familiar with the technologies brought by the fourth industrial revolution, as well as the attitude towards the coming technological wave and self-efficiency in their application.

According to Nguyen and Nguyen (2020), behaviour intentions are the precursors of real usage of technologies of Industry 4.0. This has been confirmed in an earlier paper by Cao et al. (2009) that an intention tends to positively associate self-efficacy and attitude with the actual utilisation of Industry 4.0 technologies.

2.1. Familiarity with different technologies of Industry 4.0 in SMEs

The acceptance of the various technologies of Industry 4.0 by SMEs implies developing competencies and knowledge for their implication. SMEs focused on technological and innovative fields can develop sets and accomplish transformation to transform Industry 4.0 (Tortorella et al., 2020). Ahrens and Spottle (2015) emphasise that SMEs need comprehensive knowledge and familiarity with new technological paradigms because the level of complexity of business processes in Industry 4.0 increases. Therefore, the demand for new skills is necessary, including digital communication and integration of all elements Industry 4.0 concept (Hecklau et al., 2016). Those elements in science literature indicate the trend of automation and data exchange in manufacturing technologies. It includes Cloud computing, the Internet of Things (IoT), Big Data, 3D printing and robotics, Virtual reality (VR), Augmented reality (AR), Supply chain management, and Artificial intelligence (AI).

2.1.1. Cloud computing

Cloud computing is evolving as more popular for enterprises and organisations. Many companies become to operate by using the clouds because it delivers a lot of many benefits. SMEs utilising cloud computing in their business have not maintained servers and software on their premises (Javaid, 2014). Also, professional staff should not be hired to maintain the IT infrastructure, which also reduces reducing maintenance costs. Cloud computing offers SMEs to rent server space, which can be located anywhere in the world in the world, to access their software applications. Many large corporations have started their cloud business, which is expected with SMEs as well. The benefit that SMEs can expect with the implementation of Cloud computing is cost savings (Chien & Chien, 2010). They do not need to invest in hardware they will not use in whole, but they can only pay for what they have employed. Consequently, there are a number of benefits that SMEs can have by applying cloud computing. Some of them may be easy availability, scalability, flexibility, etc.

2.1.2. The Internet of Things (IoT)

Internet of Things (IoT) is a technology that connects a device to the internet and other related devices. IoT is a vast network of connected things and people, where everyone collects and shares information about how they are used and the environment surrounding them (Turan et al., 2019). This includes an exceptional number of items of all shapes and sizes, such as self-driving cars whose complex sensors detect objects on the road. Also, it comprises wearable fitness devices that measure heart rate and the number of steps taken during the day and many other ways of connecting. Consequently, IoT is a technology that connects all kinds of physical devices to the Internet (Suciu et al., 2021). Specifically, it is a system of physical devices that receives and transmits data using wireless networks, in which human intervention is not required. IoT can benefit SMEs because it encourages companies to reconsider how they approach their business and gives them tools to improve business strategies. In addition to increasing employee productivity, it also improves the users' experience. Likewise, IoT allows companies to monitor their overall business processes, saving time and money. By integrating and adapting business models, IoT enables SME managers to make better business decisions, generating higher revenue (Brous, 2020; Shin, 2017).

2.1.3. Big Data

Big Data is a concept that refers to information that cannot be processed and analysed in the traditional wa traditionally, using conventional processes and tools (Dumbill, 2013). It is a data set that goes beyond the capabilities of classical database management software to collect, store and process, manage, and analyse. In this regard, this concept relies on the visualisation of visualising large amounts of data (Coleman et al., 2016). Today, data is thought the most valuable asset of any company. Both l Large corporations and small and medium-sized enterprises are exploring new ways to use data (Oussous et al., 2017). Using big data is not only for multinational companies, but SMEs can also benefit from a huge amount of data to make a quick and valid decision to enhance their business operations. Big data is a paradigm change in order for SMEs to enhance the business processes during the adoption of big data. SMEs can have value from extensive data by employing and creating links with technologies of big data big data technologies, which can be used in various business aspects, such as logistics, supply chain management, customer relationship, etc. Finally, using big data in SMEs can be useful in solving key issues of business (Wamba et al., 2015).

2.1.4. 3D printing and robotics

3D printing and other technologies of Industry 4.0 change the mode of managing the business (Olsson et al., 2021). Small and medium-sized enterprises are currently facing the challenge of embracing and implementing certain technologies brought by Industry 4.0, and some of them are 3D printing and robotics. SMEs are using 3D printers to deal with a wide range of situations during business operations to produce products suitable for a new market in the Fourth Industrial Revolution. However, the capital expenditure on robotic equipment can be proved an obstacle for SMEs to invest in automation and further business development (Besklubova, 2021).

2.1.5. Virtual reality (VR)

Virtual reality (VR) is also called computer-simulated reality. This computer technology reproduces the real environment and generates realistic displays, images, sounds, and other sensations in creating the imaginary world. So, with the help of virtual reality, users can immerse themselves in a completely virtual world. Today, it can be easily said that VR is a well-established new technology utilised in companies worldwide. Likewise, SMEs can successfully use this technology to enhance workforce training and learning (Matsas et al., 2018). Furthermore, SMEs can utilise VR technology to produce an environment that will help to effectively measure decisions about realities and predict future effects (Liagkou & Stylios, 2019).

2.1.6. Augmented reality (AR)

Augmented Reality (AR) is a technology that expands a user's physical world by adding layers of digital information. It is an interactive experience of a real environment where generated computer data enriches items located in the real world. Therefore, it is a link between the real and virtual worlds. Unlike virtual reality, AR does not create readable artificial environments to replace real with virtual ones (Roxo & Brito, 2018). Instead, AR appears in a direct view of the existing environment and adds sounds, videos, and graphics. This emerging technology in Industry 4.0 will enable SMEs to offer customers a lifelike experience. Although the AR concept is in the initial phase of research, it has begun significantly impacting business operations. SMEs employing augmented reality reach certain benefits and develop their business to a new, higher level. AR enables SMEs to avoid design errors, speed up product installation, simplify repair, reduce maintenance costs, and provide logistics savings (Cranmer, 2021).

2.1.7. Supply chain management

Supply chain management is a possibility employed to effectively integrate manufacturers, suppliers, and customers in order to improve the long-term performance of not only particular organisations but also the supply chain as a whole (Hong & Jeong, 2006; Zhao & Simchi-Levi, 2002). This concept enables the successful exchange of information, materials, and cash flows (Kukalis, 1989). Supply chain management includes links between value chain entities upstream and downstream. Upstream according to production and supply, downstream according to distribution and logistics (Hong & Jeong, 2006). SMEs use supply chain management in order to reach performance requirements. SMEs can utilise supply chain management processes in demand management, product development and commercialisation, customer relationship, manufacturing flow management, quality management, and returns management (Lambert & Cooper, 2000).

2.1.8. Artificial intelligence (AI)

Artificial intelligence (AI) is a concept used in computer science. It deals with methods and technologies that enable a computer to perform those tasks that would require intelligence. AI is an Industry 4.0 technology used to increase the efficiency and effectiveness of industrial processes (Wahlster, 2017). The main goals of artificial intelligence are to enhance the quality of industrial processes, decrease costs, save time. Also, artificial intelligence facilitates the renewal of production and associated processes and the enrichment of own products or services by applying the new business models (Kumar, & Kalse, 2021; Bunte et al., 2021). However, challenges faced by SMEs in application AI are a lack of knowledge and expertise in the field of artificial intelligence. Also, the application of AI by SMEs is mainly limited due to the basics of infrastructure and employees who will work on the implementation of AI (Bunte et al., 2021).

Following and analysing the technologies of Industry 4.0, it can be noticed that SMEs are mainly facing some challenges in their business in the new market. In order to accept all the mentioned technologies, SMEs should be aware of the benefits of their application, have an attitude towards digitalisation, to believe that digitalisation will give them a competitive advantage and business efficiency. In this light, the following hypotheses have been developed:

Hypothesis 1. Familiarity with the technologies of Industry 4.0 is an important prerequisite for the positive attitude towards its application in SMEs.

Hypothesis 2. Familiarity with the technologies of Industry 4.0 has a positive effect on self-efficacy in SMEs.

2.2. Attitude of SMEs toward Industry 4.0 technologies

Many researchers have noted that for the understanding of the Industry 4.0 concept, the attitudes of SMEs towards advanced solutions vary from industry to industry. Similarly, since Industry 4.0 is inevitable, SME owners' attitudes towards adopting Industry 4.0 technologies vary depending on technology, knowledge, and costs. Even if SMEs are ready to enhance the quality and competitiveness of the products, they have a caution to invest in new business models (Müller et al., 2017). It is important to mention that SMEs can have a positive attitude according to acceptance of Industry 4.0 if they are familiar and have experience and expertise to work with Industry 4.0 technologies. Managers with an entrepreneurial attitude and strategic focus can predict the possibilities and business value in Industry 4.0 technologies (Hamada, 2019). However, a deficiency of positive value perceptions in new technologies adoption fails to perceive the strategic integration of these new technologies with their business model (Milošević et al., 2019; Jones et al., 2014). Managers' positive attitudes could lead to their acquisition of knowledge and supplementing deficiencies of resources which primarily relate to skilled workers required for

companies to adapt to the new technologies of Industry 4.0. Based on this consideration, stems the following hypothesis:
Hypothesis 3. The positive attitude of SMEs towards the technologies of Industry 4.0 has a positive orientation towards the behaviour intention in their application.

2.3. Self-efficacy in digitalisation

For an organisation to accept a certain technology, it depends on how much managers and employees believe it will help them. According to self-efficacy theory, anticipations such as feelings, performance, and motivation determine affective behaviour and reactions in most situations. If the technology is considered useful, it is more likely that managers and employees will adopt and use it in the future (Baker-Eveleth & Stone, 2008; Henry & Stone, 2001). In many studies, self-efficacy has a predictive role in determining behaviour intention during acceptance of new technologies (Fathema et al., 2015; Tsai et al., 2011; Park, 2009;). Self-efficacy also appears in the literature as an important construct in predicting managers' and employees' motivation and learning (Hii et al., 2013). For this reason, in this paper, self-efficacy appears as a predictor of behavioural intention. In this light, the following hypothesis has been developed.
Hypothesis 4. Self-efficacy in the application of Industry 4.0 technologies has a positive orientation towards the behaviour intention.
A conceptual model was proposed based on theoretical reviews and developed hypotheses, depicted in Figure 1.

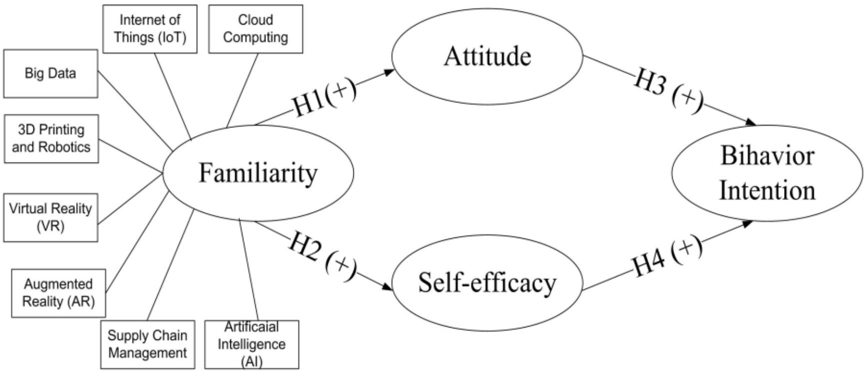

Figure 1. Conceptual model

3. METHODOLOGY

3.1. Sample and data collection

For the purposes of research, a survey was carried out in which data were compiled through an online questionnaire. The questionnaire was distributed to managers of SMEs through personal e-mail and the platform LinkedIn in the second half of 2021. The questionnaire was fundamentally contained of two groups of questions. The first group reveals the demographic characteristics of respondents (age, gender, position in the company, years of work experience, level of education, dominating sector of the company, etc.). The second group of questions is related to the level of familiarity technologies of Industry 4.0 and behavioural intention, attitude, and self-efficacy in applying digital technologies. 134 correctly completed questionnaires were collected to analyse the obtained results. Likert's five-point scale was employed to obtain results. The demographic profile of the respondents is depicted in Table 1.

Table 1. Demographic profile of respondents

Demographic variables	The composition of the sample	
	Categories	Percentage (%)
Gender	Male	67.2
	Female	32.8
Age	18 - 30	26.8
	31 - 45	49.3
	46 - 60	21.6
	61 +	2.3
The position in the company	The owner	20.9
	Manager	42.5
	Employee	36.6
The years of work experience	Up to 5 years	27.6
	From 6 to 10 years	28.4
	From 11 to 20 years	25.3
	More than 20 years	18.7
The level of education	Elementary school	/
	High school	13.4
	Bachelor	37.3
	Master	41
	PhD.	8.3
The dominating sector of your company is	Production	49.3
	Trade	8.9
	Services	41.8

3.2. Data analysis

Based on proposed hypotheses, the conceptual model was developed, for whose analysis the SEM methodology (Structural Equation Modelling) was utilised. For this purpose, the software SPSS v.21 and AMOS v.18 were used.
The analysis of the obtained results was conducted through two steps. . The measurement model was evaluated using Confirmatory Factor Analysis (CFA) in the first step. In the second step, the Structural Equation Model (SEM) and the path coefficients were estimated (Hair et al., 2006).

The CFA results indicated an acceptable level of data fit, thereby confirming the model's validity (Table 2). Furthermore, the obtained fitting index values are in accordance with the recommended values (Hair et al., 2006; Byrne, 2004).

Table 2. Fit indices for the measurement model

χ^2(p<0.05)	χ^2/df	RMSEA	CFI	NFI	TLI	IFI	RFI
χ^2=189.7 df=147	1.29	0.047	0.983	0.929	0.978	0.983	0.908
Accepted fit	<3	<0.08	>0.90	>0.90	>0.90	>0.90	>0.90

In Table 3 can be seen that all factors loading had satisfactory statistical significance (p <0.01), which were over 0.5, according to literature recommendations (Geyskens et al., 2006; Byrne, 2004; Hair et al., 1998). The convergent validity and internal consistency of the model were tested. In Table 3, it can be seen that all AVE values are above 0.50, which confirms that convergent validity has been achieved (Hair et al., 1998). Also, in the same table are the values of the Crombach coefficient that are over 0.70, which also indicates that the reliability of the measuring scale has been achieved (Cronbach, 1951).
The Fornell-Larcker criterion was applied to assess discriminant validity as shown in Table 4. All values of discriminant validity are presented on the diagonal with bold letters and have values above 0.7, which indicates that an acceptable correlation has been achieved between the observed constructs (Fornell & Larcker, 1981).
Next, the SEM was utilised to test the relationships among all the investigated constructs. The excellent overall goodness-of-fit model to the data has resulted from structural analysis (χ^2=1.321, CFI=0.981, NFI=0.927, TLII=0.975, IFI=0.981, RFI=0.906, RMSEA=0.049).

Table 3. Results of the Measurement Model

Constructs	n	Standardised factor loading	Critical ratio (t- value)	AVE	Cronbach Alfa
Familiar with Industry 4.0	8			0.613	0.926
Q1		0.584	-		
Q2		0.731	8.688		
Q3		0.660	6.298		
Q4		0.801	8.280		
Q5		0.953	7.889		
Q6		0.911	7.748		
Q7		0.739	6.803		
Q8		0.819	7.330		
Attitude towards digitalisation	5			0.667	0.917
Q1		0.851	-		
Q2		0.792	10.041		
Q3		0.789	9.378		
Q4		0.834	10.726		
Q5		0.815	14.168		
Self-efficacy	4			0.670	0.903
Q1		0.772	-		
Q2		0.964	11.273		
Q3		0.793	10.154		
Q4		0.725	9.151		
Behaviour Intention	3			0.931	0.976
Q1		0.960	-		
Q2		0.993	34.900		
Q3		0.945	26.202		

Standardised factor loading and t-values between observed and latent variables are shown in Table 5.

Table 4. Correlation Matrix and Discriminant Validity

Constructs	Familiar with Industry 4.0	Attitude towards digitalisation	Self-efficacy	Behaviour Intention
Familiar with Industry 4.0	**0.782**			
Attitude towards digitalisation	0.394**	**0.816**		
Self-efficacy	0.009	0.195	**0.818**	
Behaviour Intention	0.333**	0.545**	0.001	**0.965**

p<0.01

Also, the standardised regression coefficients and the variances for the dependent constructs are depicted in Table 5. The value of R^2 is 74% of the variance of behaviour intention in the application of Industry 4.0 technologies. This is a very satisfactory level to define the linear relationship between the constructs of attitude, self-efficacy, and the final dependent construct, behaviour intention.

Table 5. Standardised factor loading and t-values

Variables	n	Standardised factor loading	Critical ratio or (t-value)	R^2
Familiar with Industry 4.0	8	0.583- 0.952	6783-8.662	-
Attitude towards digitalisation	5	0.778-0.851	9.309-14.222	0.39
Self-efficacy	4	0.706-0.881	4.738-11.194	0.81
Behaviour Intention	3	0.947- 0.961	26.693-1.205	0.74

Finally, the hypotheses H1, H2, H3, and H4 were analysed by computing the standardised direct impacts. The results of the path analyses are depicted in Table 6 and Figure 2.

Table 6. Path coefficients and T-values

The relationship or path	Standardised parameters	T-value	Causal relations
H1. Familiar with Industry 4.0 - Attitude towards digitalisation	0.387 (a)	4.038	***
H2. Familiar with Industry 4.0 - Self-efficacy	-0.010	-0.104	-
H3. Attitude towards digitalisation - Behaviour Intention	0.573 (a)	6.434	***
H4. Self-efficacy - Behaviour Intention	-0.097	-1.361	-

(a) Significant at the 99% level

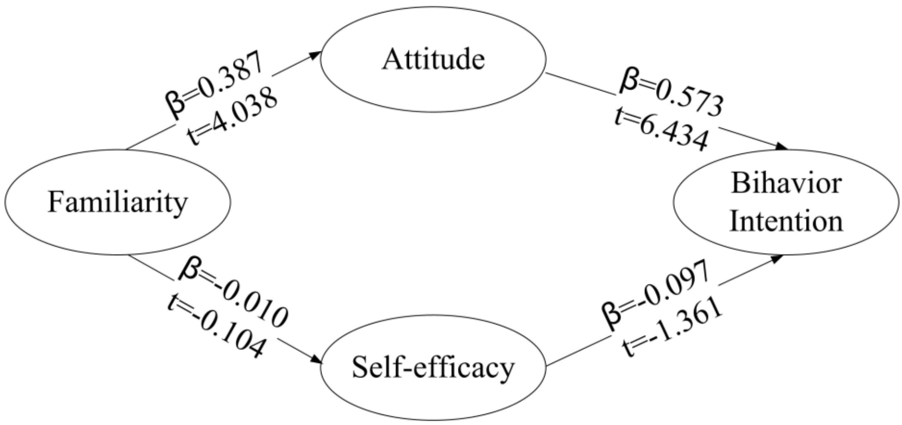

Figure 2. Structural model

4. DISCUSSION OF THE RESULTS

Utilising Structural Equation Modelling, four proposed hypotheses were tested in the research. The results demonstrate that two analysed hypotheses in the model have positive values for the path coefficients, and two proposed hypotheses have a negative path direction.

In hypothesis H1, it was assumed that familiarity with the technologies of Industry 4.0 is an important prerequisite for the positive attitude towards its application in SMEs. This claim is confirmed by the obtained results, in which the beta coefficient is 0.387, and the t-value is 4.038. This result is comparable to the research conducted by Hamada (2019).

Hypothesis 2, which states, "Familiarity with the technologies of Industry 4.0 has a positive effect on self-efficacy in SMEs" is rejected because the beta coefficient is -0.010 with a t-value of -0.104. According to the research of Baker-Eveleth & Stone (2008), Henry & Stone (2001), if the technology is familiar and considered beneficial, it is more likely that SMEs will accept and employ it in the future business. These facts are opposite to the results of this research. However, there is no guarantee that familiarity and understanding of the benefits of new technologies will contribute to greater self-efficacy in the future, already are required knowledge, experience, and expertise in working with new technologies. Hence, this result is justified.

Further, hypothesis 3 indicates that the positive attitude of SMEs towards the technologies of Industry 4.0 can have a positive orientation towards the behaviour intention in their application. This hypothesis (beta coefficient= 0.573 and t-value of 6.434) is accepted, confirming the previous findings in the research by Saeed et al. (2020).

Finally, hypothesis 4 states, "Self-efficacy in the application of Industry 4.0 technologies has a positive orientation towards the behaviour intention". This hypothesis is not accepted because it has a negative direction with a beta coefficient of -0.097 without statistical significance with a t-value of -1.361. The obtained result is in line with the findings of Jones et al. (2014). A lack of positive perceptions of values such as self-efficacy, motivation, and self-assessment can fail in the intention to apply new technologies.

5. CONCLUSIONS

The theoretical contribution of this study is reflected in the understanding of how SMEs can evolve into innovative ones. Thus the gap in the literature was filled. Also, this paper has a practical contribution. Considering that the aim of the research was to examine relationships among attitudes toward digitalisation, self-efficacy, and behaviour intention based on familiarity with technologies of Industry 4.0 in SMEs in Serbia, the results of this research can help managers of SMEs in their intention to create technology strategies according to Industry 4.0 concept.

This study delivers valuable insights with some limitations regarding the sample size and type of the enterprises that participated in the study. The sample collected via LinkedIn limits the possibility of generalising the results. Since it is believed that a familiarity with the technologies brought by Industry 4.0 may affect behaviour intention in their application, further research could cover several different constructs that would bring closer how new technologies can positively affect the business performance.

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DIGITALISATION IN HUNGARIAN SMEs - TECHNOLOGY OR CULTURE?

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Abstract

Digitalisation and sustainability are by far the two most dominant megatrends in the latest decades. The business implications of these two areas and the relationship between the two trends are popular research topics among both academics and practitioners. Each company has its own ability to adapt and respond to changing environmental challenges and it is an unfortunate fact that some of them are not always able to implement the latest technologies to their practices. Small- and medium-sized enterprises are particularly vulnerable in this respect, for whom digitalisation in particular is not just a competitive advantage but an unavoidable imperative of development, without which their survival may be at stake. Based on the opinions of 112 Hungarian small- and medium-sized company owners and top managers, this paper aims to explore the relationship between digitalisation and corporate sustainability in the SME environment, in order to identify the most appropriate development strategies to meet the needs of such businesses. The results showed that respondents have a realistic view of the impact of digitalisation on

the sustainability dimensions and that they see the benefits of digital transformation mainly in terms of positive economic impacts.

Keywords: *Digitalisation, SDG, SME, Sustainability, TBL*

1. INTRODUCTION

In the last two decades digitalisation has become one of the key issues in business processes. First capital-strong and market leading companies invested in digitalisation in their business operations then digitalisation has proliferated in the business development of small- and medium-sized companies (SMEs) as well. At the same time the last decades brought sustainability into the front and foster companies of any size to digitalise so that their business operations support sustainability.

According to recent research by Accenture and Business Europe, rapid investment in digital technology and sustainability could create up to 5.7 million new jobs in Europe by 2030. The researchers also stated that such development will require enabling environmental conditions. The analysis concludes that it is important, among other priorities, to support high-potential sectors, pay attention to education and, last but not least, stimulate the digital transformation and the transition to a sustainable economy by introducing integrated technological infrastructure (AI, 5G, Cloud, IoT) and supporting decarbonisation efforts (AC, 2021). There is no question that both governments (regulatory bodies) and companies will have an important role to play in realising these ambitions (Accenture, 2021).

This paper aims to reveal how SMEs in Hungary approach digitalisation and sustainability, what positive and negative effects of digitalised processes they experience in relation to sustainability.

The paper formulates three research questions, namely:

RQ1: How does digitalisation contribute to sustainability according to SMEs?

RQ2: What are the benefits and the drawbacks of digitalisation on business processes in terms of sustainability amidst SMEs in Hungary?

RQ3: How do the demographic characteristics of enterprises (age, size, field of activity) influence their perceptions of digitalisation and sustainability?

The paper is organised as follows: after the literature review, it presents research methodology and data collection methods, then the next section gives the demographic profile of the sample and presents the responses of the participants. The discussion part follows in which the authors find arguments for the research questions and the paper closes with the conclusion section.

2. DIGITALISATION AND SUSTAINABILITY

To explore the relationship between digital transformation and sustainability, it is first necessary to clarify the two concepts. Based on the literature, sustainability has been defined in a variety of ways, but no single agreed definition has emerged over the last decades. Perhaps the most commonly cited definition is that of the Brundtland Report (1987), which defines sustainability as 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs' (Keeble, 1988). Critics of the definition, however, argue that this cannot be called a coherent, scientific approach in the strict sense (Málovics & Ván, 2008). Another shortcoming of this traditional interpretation of sustainability is that it fails to take into account that sustainability is not an ideal state but it rather should be seen as an ever-changing, evolving set of objectives (Szalavetz, 2018).

In corporate practice, sustainability typically manifests itself in the form of corporate social responsibility. It is important to emphasise that the concept of CSR and corporate sustainability do not override economic considerations; on the contrary, according to this concept, profitable operation is achieved by taking other interests into account and integrating them into corporate objectives. The principles of such responsible corporate action are perhaps best captured by the 'Triple Bottom Line' (TBL) [1] theory, developed by Elkington in 1984, according to which companies create economic, social and environmental values (Elkington, 2018) and strive to manage these pillars in a balanced way in order to achieve responsible operation.

Digitalisation, along with sustainability, can only be understood in its exact context, whether it is approached from a technical or business perspective. The literature, therefore, distinguishes between technical and business digitalisation (Șerban, 2017). In technical terms, digitization or digitalization means basically capturing an analogue signal and converting it into digital form for the purpose of generating a digital representation that can be electronically stored or processed (Kayikci, 2018). In the context of this study, digitisation is understood as a business term that refers to newly created business models and processes. In all such new strategies, the focus is on the benefits derived from digitised products (Gubán & Sándor, 2021). Digitalisation can, therefore, be understood as a transition to digital business (Gartner, 2019).

Digitalisation and sustainability are game-changing and strategic imperatives that are driving major transformations on both macro and micro level. The convergence of digitalisation and sustainability seems to be a winning combination, but not exempt of problems, offering opportunities to overcome the challenges of information flows within and across organisational boundaries (Kiron & Unruh, 2018). According to other scholars these two are conflicting concepts leading to a paradigm shift in social and ecological systems (Gebhardt, 2017). However, the nexus between the two concepts is still poorly understood and little is known about whether and to what extent digitalization can contribute to or threaten sustainability (Seele & Lock, 2017).

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[1] *TBL meaning triple bottom line, when except of one bottom line being the profit, there are three: people, profit and planet.*

If we accept the ever-changing, adaptive nature of sustainability, it is predictable that its drivers will adapt to the challenges of digitalisation, while digital innovations will follow sustainability norms (Seele & Lock, 2017). This unique dynamic of these two domains is of interest to researchers from several perspectives. A significant body of research explores the interrelations between the two areas with a holistic, systematic view (including economic structure, regulation etc.), identifying direct and indirect, positive and negative effects (Szalavetz, 2018). Beneficial direct effects include increased ecological efficiency, while indirect effects concern social and cultural transformation, though negative effects of the latter are also highlighted in studies (Brenner & Hartl, 2021). Examples of negative effects include increased consumption of raw materials and energy, and the environmental impact of electronic waste (Szalavetz, 2018). Analyses using this complex, holistic approach typically look for relationships between sustainability and digitalisation along the three pillars of TBL theory (Szalavetz, 2018; Brenner & Hartl, 2021), while some scholars further narrow the scope to concentrate specifically on the relationship between the Sustainable Development Goals (SDGs) and digitalisation (Castro, Fernández, & Colsa, 2021; Linkov, Trump, Poinsatte-Jones, & Florin, 2018; Ordieres-Meré, Pietro Remon, & Rubio, 2020). The (SDGs) of the United Nations 2030 Agenda emerged in 2015. The agenda includes 17 goals and 169 targets or objectives that emphasizes a holistic approach to achieving sustainable development for all (United Nation Development Programme, 2021). The complexity of the topic is also captured by the research that explores digitalisation as an indicator within the popular sustainability indices (Parapatits, 2018). The study has found that digitalisation is not directly reflected in any of the 37 most popular UN-accepted indices analysed, so the indicators do not clearly reflect the impact of digitalisation on sustainability (Parapatits, 2018).

The relationship between the two phenomena/trends is a popular area of research at the enterprise, micro level as well. A number of scholars search for possible connections from organisational knowledge, innovation ability and new sustainable business models (Gregori & Holzmann, 2020; Acciarini, Borelli, Capo, Cappa, & Sarrocco, 2021) perspective, others emphasise the importance of digital knowledge and information transfer (Ordieres-Meré, Pietro Remon, & Rubio, 2020; Hegyes, Csapó, & Farkas, 2017). Further papers have narrowed the focus of their analyses to specific sectors, such as logistics, transport (Kayikci, 2018), manufacturing, industry (Demartini, Evans, & Tonelli, 2019; Chen, Despeisse, & Johansson, 2020) or to certain business activities, such as sales marketing (Shpak, Kuzmin, Dvulit, Onysenko, & Sroka, 2020) or product development, product life cycle (Ordieres-Meré, Pietro Remon, & Rubio, 2020). These analyses typically revealed a broad convergence of digitisation and sustainability in the respective areas. In the field of logistics, Kayikci (2018) argues that digital technology has a significant sustainability impact, particularly in economic aspect and less on the environmental and social dimensions. Regarding the impact of digitalisation on the product life cycle, it was found that, contrary to preliminary expectations, digitalisation will continue to shorten product life cycles, as innovation is fostering product replacement, and as a result of product obsolescence product usability experience is steadily decreasing (Ordieres-Meré, Pietro Remon, & Rubio, 2020). The most comprehensive convergence was found for industrial and manufacturing companies. Research conducted among enterprises in the sector has revealed positive effects of digitalisation in terms of costs-, carbon emission-, raw material consumption- and waste reduction, and implicit benefits in terms of improved customer satisfaction (Demartini, Evans, & Tonelli, 2019).

Recent studies focusing on small- and medium-sized enterprises have all underlined the need for digital transformation (Bai, Quayson, & Sarkis, 2021; Marcysiak & Pleskacz, 2021; Denicolai, Zucchella, & Magnani, 2021). The significant economic impact of the pandemic has created new challenges for small firms, which have moved towards increased digitalisation, particularly in their sales and distribution management, in line with their primary business priorities (Marcysiak

& Pleskacz, 2021). However, limited resources may be a barrier to the development and growth of SMEs. Going international, operating sustainably and implementing digital transformation are, among others, three possible growth strategies that few small enterprises can achieve at the same time. Scholars have found that SMEs open to internationalisation pay more attention to sustainability, and, furthermore, they also argue that the higher the readiness towards sustainability within a small company, the lower is the positive association between digitalization readiness and internationalization (Denicolai, Zucchella, & Magnani, 2021).
In conclusion, based on literature review, the relationship between digitization and sustainability is indisputable, however, further analysis of the relationship dimension seems to be essential in the future. In addition to a more in-depth exploration of the dimensions, there are also scientific gaps in terms of research methodologies as further quantitative analysis is needed to verify the parameters already identified through case studies and qualitative analysis.

3. METHODOLOGY AND DATA

Present research was conducted under the project 'Possibilities and barriers for Industry 4.0 implementation in SMEs in V4 countries and Serbia'. A self-administered questionnaire was designed by the participating countries to collect data from SMEs in each V4 country and Serbia. A pilot of the survey was conducted to confirm the questions. The quantitative research used the survey method including both online and paper version questionnaire. Google form was used for the administration of the online questionnaire. The questionnaire was translated so Hungarian SMEs were invited to spends 10-15 minutes answering the questions in Hungarian. The questionnaire was disseminated among the respective SMEs in September/October 2021. Anonymity was ensured, no personal information was required. The data gathered 112 responses providing a large sample, however, the data does not give a representative sample.

The paper focuses on the questions linked to digitalisation and its impact on sustainability (13 questions) and the responses from the Hungarian SMEs are analysed. Quantitative analysis was conducted to reveal SMEs' approach to digitalisation and sustainability using the statistical programme SPSS version 25. Descriptive analysis was applied to give a general view of SMEs' approach, then ANOVA analyses were used to reveal whether the different sized and aged companies operating in different economic sectors have similar or different views on the impact of digitalisation on company sustainability.

4. RESULTS

4.1. Demographic profile

A total number of 112 questionnaires were completed by Hungarian SME owners and managers each of which could be analysed. Due to convenience sampling used for data collection the sample is not representative in terms of diversity, therefore the findings are indicative but cannot be generalized to the entire Hungarian SME population.
First, the personal characteristics of the business professionals surveyed are presented. The average age of the business experts surveyed is 46.4 years, nearly half of respondents (47,3%) aged between 46 and 60. In terms of position, three-quarters of the respondents are company owners, 16,1% are middle managers and 4,5% managers, which means that only 4.5% of the respondents are employees. Almost half of the professionals surveyed have been working for more than 20 years (49.11%), close to a third have more than 10 years and over 10% of the respondents have 6 to 10 years of work experience.
The demographic composition of the sampled companies was also asked, namely the age, size, area of business activity, business focus, and the dominant sector the company operates.

Figure shows that two thirds of the enterprises surveyed are micro enterprises (66.1%), a quarter are small enterprises (26,8%) and 6,3% are medium-sized enterprises.

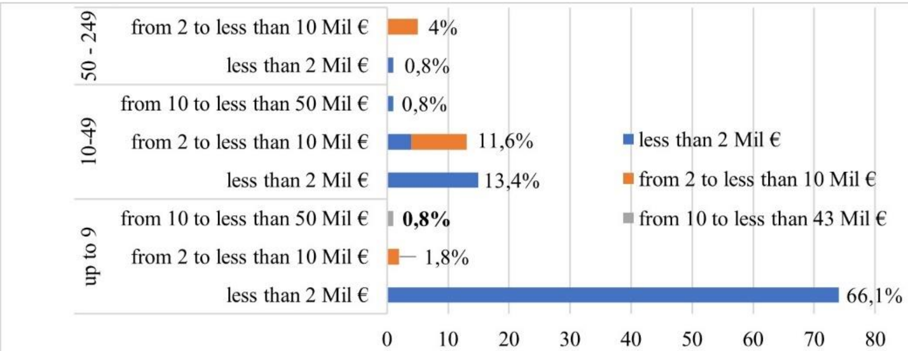


Figure 1. Division of the sample according to the size of the company
Source: Author's

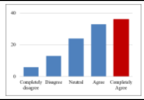
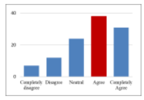
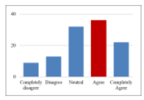
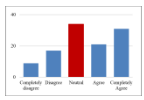
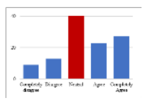
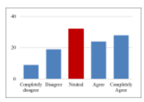
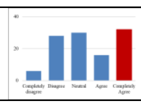
More than half of the enterprises in the sample operate in the services sector, nearly a third in the trade sector and a tenth in the production sector. The area of business distribution is as follows: more than 20% of the enterprises surveyed are in Wholesale and retail trade, 16.96% in Construction and developers, 13.39% in Information and communication, 6.25% in Manufacturing and less than 4% in Finance and insurance and Industry including energy.

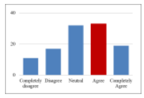
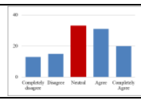
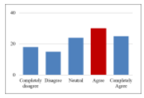
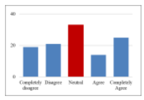
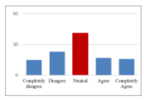
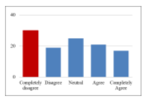
A third of the enterprises (33.9%) have been in business for 11-20 years, 25%-25% of them have been running for more than 21 years and for 6-10 years each, 8.9% have been operating for 3-5 years and only 7.1% in the sample is less than two years old, newly established enterprise.

4.2. Digitalisation and sustainability in SMEs in Hungary – general view

The section on Sustainability in relation to digitalisation among SMEs included 13 statements in which the respondents were asked to rate the statements on a Likert scale ranging from 1 – completely disagree to 5 –completely agree. The regular descriptive measures of the responses are presented in Table 17. SMEs in Hungary agreed most to the effect of digitalisation in reducing costs (61.61%) the mean equalling 3.71 with a Mode of 5) while the statement ‘digitalising the company helps to extend the lifecycle of our products’ was the least agreed with – the average being 2.79 and Mo=1). Half of the respondents (51.79%) agreed that ‘digitalising the company helps to adjust the business model to the environmental needs and requirements’ in which case the answers differed the least from each other (SD=1.169 and IQR=1). Almost two thirds of the respondents (61.61%) agreed that digitalisation helps to optimise and reduce the use of resources. Looking into the negative effects of digitalisation the highest number of the participants agreed that ‘Electronic equipment and devices produce a high amount of e-waste’ (Mo=5, AVG=3.36, SD=1.28) while responding companies were undecisive on whether ‘The production and use of ICT consume a growing amount of materials, which speeds up the depletion of natural resources’ and ‘The increasing demand for energy supply on digitalisation and data centre generates abundant emissions’. In all three cases over 40% of the responses agreed with the negative impact (42.86%, 46.43% and 44.64% respectively). On the contrary, 46.43% of the responding SMEs believe that ‘Digitalising the company helps to achieve higher productivity and less waste’, and one quarter of them disagree with it.

Table 17. Descriptive measures of responses on sustainability due to digitalisation

Statements on the relation between digitalisation and sustainability	Mean	Median	Mode	SD	IQR	Shape of distribution
2. Digitalizing the company helps to reduce costs.	**3.71**	4	**5**	1.189	2	
1. Digitalising the company helps to optimise and reduce the use of resources.	3.66	4	4	1.174	2	
3. Digitalizing the company helps to adjust the business model to the environmental needs/requirements.	3.44	4	4	**1.169**	**1**	
12. The production and use of ICT consume a growing amount of materials, which speeds up the depletion of natural resources.	3.43	3	3	1.264	2	
13. The increasing demand for energy supply on digitalisation and data centre generates abundant emissions.	3.41	3	3	1.205	**1.75**	
8. Digitalising the company helps to achieve higher productivity and less waste.	3.38	3	3	1.254	2.5	
11. Electronic equipment and devices produce a	3.36	3	5	1.279	3	

high amount of e-waste						
5. Digitalising the company helps generate value to perform fair business practices to benefit the community and society.	3.29	3	4	1.204	1.75	
10. Our company has integrated SDGs into its long-term strategy.	3.27	3	3	1.237	1.75	
9. Digitalising the company helps to achieve customised production.	3.26	3	4	1.374	2	
4. Digitalising the company helps to reduce carbon emissions.	3.04	3	3	1.378	2	
7. Digitalising the company helps to relocate funding for green investments.	2.96	3	3	1.215	2	
6. Digitalising the company helps to extend the lifecycle of our products.	**2.79**	3	**1**	1.417	3	

Source: Author's

One third of the respondents are not confident whether digitalisation helps to reduce carbon emission, while around 35% agreed or disagreed with the statement. Unfortunately, for most of the statements the responses of 'neither agree nor disagree' appeared with a high response rate ranging between 21.43% and 36.61% which implies that further research is needed to explore the issue. The phenomenon could be tracked in the response proportion whether the company had already integrated SDGs in their long-term strategy (45.54% agreed, 29.46% were undecisive and 25% disagreed. While almost 50% of the responding SMEs in Hungary agreed that ‘Digitalising the company helps to achieve customised production’, and 46% of them agreed that digitalisation has added value to fair business practices and it benefits the community and the society, a bare 30% believe that ‘Digitalising the company helps to relocate funding for green investments’.

4.3. Influence of business demographics on the perceptions of the impact of digitalisation on sustainability – ANOVA comparison

As the category name of SMEs is defined by the regulatory bodies, it includes micro-, small- and medium-sized enterprises. Therefore, the comparison of different-sized SMEs might give valuable results. Based on the maturity and life of companies as well as their digital maturity, the comparison by company age is also in the focus of the research. Finally, different economic sectors have reached different level of digitalisation and show different approaches to sustainability. The research, therefore, strived to find similarities and differences in the behaviour of enterprise with different age, size and operating in different economic sector.
Regarding the positive and negative effects of digitalisation on sustainability in the life of companies, in most of the questions enterprises with different age, size and operating in production, trade or services had similar approach and showed no significant differences. However, in some of the questions the difference was significant. How enterprises consider ‘Digitalisation as it helping to optimise and reduce the use of resources’ showed significant difference by the age and size of SMEs. By age SMEs between 3 and 5 years old agreed the most with the statement while the youngest SEMs as well as the ones between 6 and 10 years old agreed with the statement the least ($F=2.767$, $p=0.031$). The oldest companies experienced use of resource cost reduction of digitalisation (Figure 17). Regarding the same question micro-SMEs (up to 9 employees) found the benefit on the usage of resources the least useful as can be seen on Figure 18

(F=4.567, p=0.012) while small- and medium-sized enterprises (employee number higher than 10) agreed with the beneficial effect in this case.

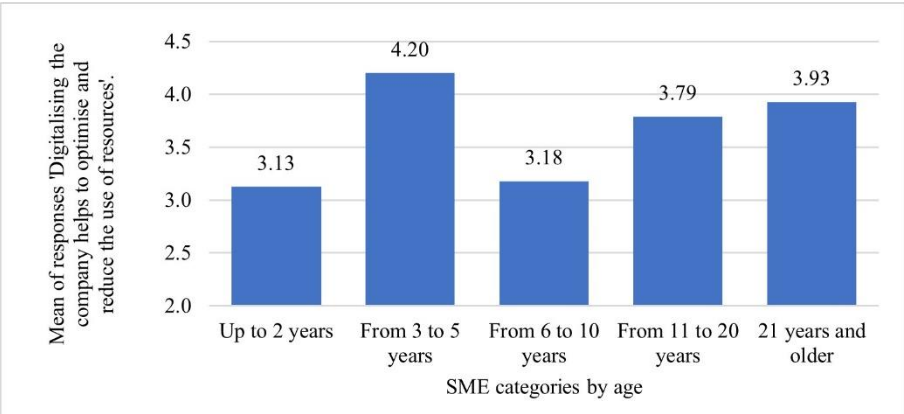


Figure 17. Evaluation of the contribution of digitalisation to optimise and reduce the use of resources by age of SMEs
Source: Author's

Further significant differences could be traced by company size, namely in cost reduction (F=4.051, p=0.020) and extension of the lifecycle of the products (F=4.697, p=0.011). While SMEs rather agreed with the positive impact in cost reduction, they generally do not agree with its impact on the extension of the life cycle products. While in both questions the significant difference was detected between micro- and small-SMEs, small-and medium-sized enterprises agreed more on cost reduction ($Mean_{Small}$=4.21 and $Mean_{Medium}$=4), and micro- and medium-sized enterprises disagreed similarly with life cycle extension ($Mean_{Micro}$=2.53 and $Mean_{Medium}$=2.83)

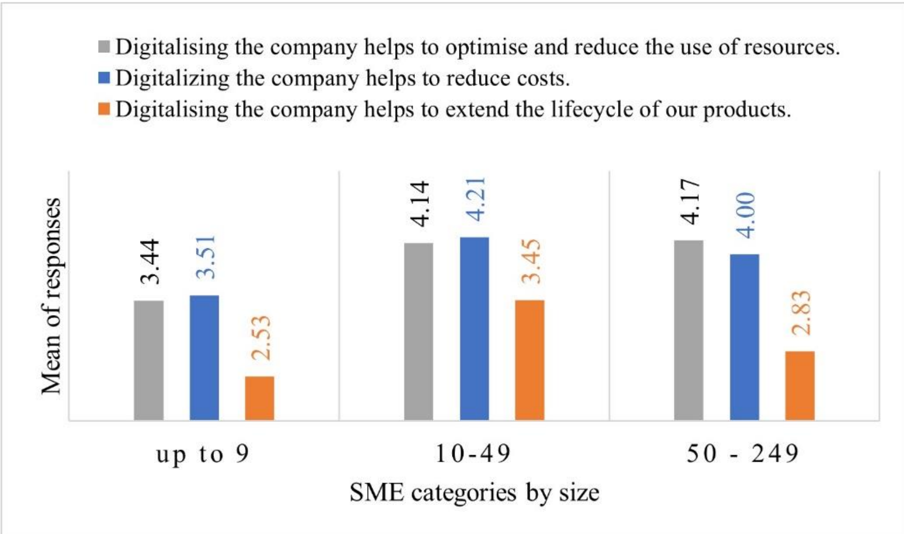


Figure 18. Evaluation of the contribution of digitalisation to optimise and reduce the use of resources by age of SMEs
Source: Author's

SMEs responded similarly to the negative impacts of digitalisation on company sustainability by age and size while the operating sector reflected significantly different considerations of the negative impact of digitalisation on sustainability, namely, in questions 'Electronic equipment and devices produce a high amount of e-waste' ($F=4.347$, $p=0.015$) and 'The increasing demand for energy supply on digitalisation and data centre generates abundant emissions' ($F=3.328$, $p=0.040$). SMEs operating in the trading and in the services sectors had different views on the negative impacts regarding the former statement while SMEs in the production and in the services sectors formulated a significantly different opinion on the latter statement (Figure 19).

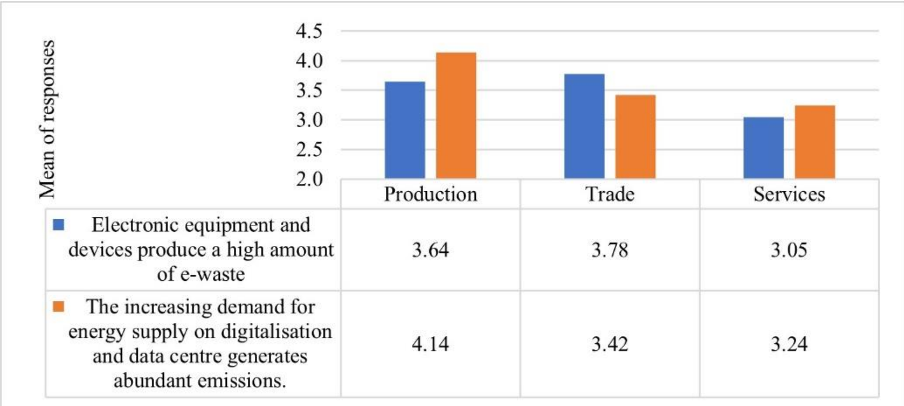


Figure 19. Evaluation of the contribution of digitalisation to optimise and reduce the use of resources by dominating sector
Source: Author's

SMEs operating in the trading sector agreed the most with the statement that digitalisation produces a high volume of e-waste, while the service industry considers that it produces less e-waste. On the other hand, SMEs in the production sector agreed the most with abundant emission while the ones in the services sector do not believe that the increasing demand for energy supply on digitalisation generates abundant emission.

5. DISCUSSION

The research paper formulated three research questions first of which was:
RQ1: How does digitalisation contribute to sustainability according to SMEs?
With regard to this first research problem, it can be concluded that SME managers have a broadly realistic view of the relationship between digitalisation and sustainability. This is confirmed by the relatively homogeneous answers to questions that confirm the dimensions of the interaction/relationship (Ordieres-Meré, Pietro

Remon, & Rubio, 2020; Szalavetz, 2018; Marcysiak & Pleskacz, 2021) already described in the literature, namely cost saving or reduction of raw material use.

RQ2: What are the benefits and the drawbacks of digitalisation on business processes in terms of sustainability amidst SMEs in Hungary?

In considering the second research question, it is also useful to draw on the literature and previous research findings. To support the interpretation of the results the statements made in the primary research question can be integrated into the triple bottom line concept (Elkington, 2018), however, each dimension concerns not only one sustainability pillar, but implicitly has an indirect impact on several areas. Accordingly, in Table 18, the statements are grouped along the TBL dimensions. Next to the statements, opinions on the impact of digitisation in a given area are shown as follows:

- + +: respondents agree on significant impact.
- +: respondents agree but perceive the strength of the impact to be less strong.
- 0: respondents agree and perceive the impact as medium.
- + –: respondents are divided in their opinion.

There was also a fairly homogeneous response regarding the impact of digitalisation on the product life cycle, which also confirms the respondents' adequate knowledge on the subject. In fact, SME owners and managers tended to disagree with the statement ‘Digitalising the company helps to extend the lifecycle of our products.’, which is in line with previous research findings showing that, despite digitisation and sustainability efforts, product lifecycles are constantly decreasing (Szalavetz, 2018; Ordieres-Meré, Pietro Remon, & Rubio, 2020).

Table 18. The relationship between digitalisation and sustainability in the light of the TBL dimensions

TBL dimensions	**Statements on the relation bw digitalisation and sustainability**	**Positive impact (perception of SMEs)**	**Negative impact (perception of SMEs)**
Economic	Digitalizing the company helps to reduce costs.	+ +	
	Digitalising the company helps to achieve customised production.	+ +	
	Digitalising the company helps to relocate funding for green investments.	**0**	
Economic/ Environmental	Digitalising the company helps to optimise and reduce the use of resources.	+ +	
	Digitalizing the company helps to adjust the business model to the environmental needs/requirements.	+ +	
	Digitalising the company helps to achieve higher productivity and less waste.	+	
	Digitalising the company helps to extend the	– –	

	lifecycle of our products.		
	The production and use of ICT consume a growing amount of materials, which speeds up the depletion of natural resources.		+ –
Environmental	The increasing demand for energy supply on digitalisation and data centre generates abundant emissions.		+ –
	Electronic equipment and devices produce a high amount of e-waste		+–
	Digitalising the company helps to reduce carbon emissions.		**0**
Social	Digitalising the company helps generate value to perform fair business practices to benefit the community and society.	+	

Research participants were more ambivalent regarding negative environmental burdens. The distribution of responses suggests that many respondents are concerned about the environmental pressures of digitalisation, while others do not see the problem as so serious. In the question ‘Electronic equipment and devices produce a high amount of e-waste’, the largest proportion of respondents strongly agreed with the statement (Mode=5), but there were also a very large number of individuals who marked a scale of 2 and 3, indicating that for them this impact is not so obvious.

According to the answers to the questions concerning business models (not shown in the table), the research found that the majority of respondents agree that digitalisation can help SMEs move towards sustainability by encouraging them to implement new business models (Gregori & Holzmann, 2020; Acciarini, Borelli, Capo, Cappa, & Sarrocco, 2021). However, as regards the current prevailing business practices of SMEs, the responses suggest that they only partially integrate sustainability objectives into their business strategy.

RQ3: How do the demographic characteristics of enterprises (age, size, field of activity) influence their perceptions of digitalisation and sustainability?

The research shows that the demographic characteristics of companies have only a small impact on perceptions of the relationship between digitalisation and sustainability. Among others it was found that the larger the company (in terms of number of employees), the more likely it recognises the impact of digitalisation in terms of cost reduction. As regard the use of resources, it is mostly business owners and managers of companies with between 10 and 49 employees who perceive such positive benefit of digitalisation.

In general, although with limitations, it can be concluded that the impact of digitalisation in the economic dimension of TBL is more noticeable for larger-sized SMEs. However, it is also important to note that, due to the composition of the sample (micro enterprises are over-represented), further research is needed to confirm this result.

As regards the limitations of the research, first it is worth mentioning the size and composition of the sample, which does not allow for a broad generalisation of the findings. Further problem is the use of guided questions used in the survey due to the quantitative methodology, which did not allow for the formulation of possible additional opinions that might differ from the statements made. In the future additional qualitative or quantitative research may provide a more accurate picture.

6. CONCLUSION/SUMMARY

This study explored the relationship between the digital transformation of SMEs and sustainable business operations. A quantitative survey among Hungarian SME owners and managers found that respondents have a realistic view on the issue. Participants perceived and identified relationships between the impacts of digitalisation and the sustainability dimensions highlighted in the literature.
For SMEs, as for key of Hungarian economy in general, it is very important not to become victims of increasingly fierce competition. Flexibility and openness to new opportunities are essential to adapt to the ever-changing environmental challenges. In this respect, small firms have a lot to offer and a lot to learn, both in terms of digitalisation and sustainable operations. Economic efficiency is a real watchword for SME managers, and it is what typically drives these business actors to undertake changes. Therefore, for SMEs, considering that they are generally aware of the cost-cutting effects of it, digital transformation might be the right strategy to start with. The implicit benefit of digitalisation is a shift towards more sustainable operations, which later, as a consequence of organisational learning, will fortunately create competitive advantage for an increasing number of small- and medium-sized enterprise.

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SMART CRANES IMPLEMENTATION IN SERBIAN SMEs

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Abstract

Previous research in the last years estimates that cranes cause over 30% of fatal accidents out of the total number of accidents in the industry. However, it still ignores biomechanical and visual problems during every day crane operators' work. Industry 4.0 solutions, such as visual guidance system, such as one proposed in project SPRINCE, have the potential to lower the rates of accidents caused by impacts between the crane or its load and objects or other equipment, which as primary cause have operator's limited or poor visibility of the surrounding workspace. This chapter analysis human and organizational factors and gives an economic appraisal on the visual guidance system installed in the Serbian context. It has been concluded that special attention must be paid to the visual guidance systems' interface design and leadership and administration factors. Also, it has been confirmed that savings resulting from the exploitation of the VGS are € 6776 per year if installed on the existing cranes in Serbian SMEs. Accordingly, the idea of using a visual guidance system installed in a Serbian context is economically justified.

Keywords: *Smart cranes, Visual guidance system, Human and organizational factors, Economic appraisal*

1. INTRODUCTION

Cranes, as a group of the most widely used machines in material handling, are particularly interesting examples of modelling complex cases.

Previous research estimates the cranes cause over 30% of fatal accidents out of the total number of accidents occurring in the construction industry. At the same time, its consequences pose additional material damage, sick leave and reduced employee motivation, often including injuries at work and/or deaths of employees in the immediate vicinity of the production plant or construction site (Milazzo et al. 2015; Brkić et al., 2020a; Sadeghi et al., 2021; Häkkinen, 1993; Brkić et al., 2020b). Wiethorn (2014) observed the structure of primarily and secondarily responsible persons responsible for accident accidents over 30 years period and concluded that in 94% of crane accidents, the human factor had a significant impact.

Accidents rates are not surprising due to the fact that developing procedures are still based on the specific experience of the manufacturer and historical guidelines, while the fact that anthropometric characteristics of operators change over time is neglected (Milazzo et al., 2021; Essdai et al., 2018; Brkić et al., 2021; Spasojević Brkić et al., 2016; Brkić, V. et al., 2015; Zunjic et al., 2015; Brkić et al., 2020b; Brkić, V. et al., 2020). Numerous biomechanical and visual problems are presented today during the crane operators' work (Veljković et al., 2015; Essdai et al., 2018; Brkić et al., 2021; Spasojević Brkić et al., 2016; Brkić et al., 2015). Cheng & Teizer (2018) additionally point out accidents due to impacts between the crane or its load and objects or other equipment and diagnose that they are often caused by limited or poor visibility of the surrounding workspace.

Modern solutions close to the industry 4.0 concept are rarely examined in the cranes field. Yu (2017) also studied the accidents that occurred when working with cranes. Also, they proposed the implementation of automatic communication of lifting equipment and web-based software tools, smart abbreviations attached to lifting equipment based on IoT technology. Yu (2017) proposed the idea to create two technologies based on smart cards - one is based on Near Field Communication while the other is on Bluetooth Low Energy and concluded that preparing data in this way will enable the creation of large databases on inspections, which will greatly improve the understanding of the root causes of incidents and contribute to their future reduction.

The typical interface in contemporary crane cabins is quite simple in control commands. Hence, the precise movement of the load requires an exceptional sense of the operator's dynamics and an exceptional sense and ability to effectively stop the mass in motion (Neitzel et al., 2001; Beavers et al., 2006; Barron et al., 2005; Commission Communication, 2007; Glock et al., 2019; Tu et al., 2021). As a rule, the visibility of the crane operator's environment is limited (Barron et al., 2005; Fang, 2018; Majewski and Kacalak, 2017; Milazzo et al., 2015; Veljković et al., 2015; Zhou et al., 2018; Cheng and Teizer, 2014; Spasojević-Brkić et al., 2014;). For these reasons, the need for a new solution to the problem of visual tension of the operator is growing (Spasojević-Brkić et al., 2014; Spasojević-Brkić et al., 2015; Milazzo et al., 2015; Veljković et al., 2015; Milazzo et al., 2021; Ancione et al., 2020; Essdai et al., 2018). Accordingly, it is necessary to improve the performance of industrial cranes with an innovative way of managing using real-time visual feedback (Spasojević-Brkić et al., 2015; Dondur et al., 2020; Cheng and Teizer, 2014).

Motivation for the development of a system for visual guidance of smart cranes is the result of the following needs, i.e. state of the art in the field:

- The need to reduce the risk of injuries at work, as required by the Commission of the European Communities in document (Commission Communication, 2007), where it is proposed that the application of ergonomic principles in design be introduced into national strategies to reduce risks at work.

- The problem of the operator's limited field of vision needs to be addressed.
- The need to improve the productivity of cranes.

The need to implement ergonomic and safety improvements in order to improve working conditions, working methods, efficiency, productivity, occupational safety and health of crane operators, all according to the recommendations of the European Agency for Safety and Health at Work.

Authors in Glock et al. (2021) present data on the impact of ergonomic adaptation on the economic performance of SMEs, while authors in (Tu et al. 2021; Park & Kim, 2017) emphasizes the importance of adapting work and the workplace to the employee, especially in terms of the choice of work equipment and working methods. For these reasons, the SPRINCE project (Spasojević-Brkić et al., 2015; Spasojević-Brkić et al., 2017) is guided by the main innovative idea in the synergistic effect of the following fields of development and innovation:

- typical crane operator interfaces actually are simple in terms of the number of commands/controls, thus an exceptional sense of its dynamics and very high level of attention and concentration is needed from operator side, in aim to to effectively stop the moving mass;
- there is the necessity to reduce the productivity drop caused by human-machine interface problems, and there are large financial losses due to the cost of accidents, then there are the costs for frequent repairs, there are frequent disturbance in material handling schedules and the increased work-load on other equipment and their higher downtime and break down times;
- there is a need to manage emerging risks, derived by the increased use of integrated operations/remote operations in transportation tasks, by means of an improved virtualization technology.

Innovation associated to this technical solution lies in offering the following:

- a best platform improving the positioning performance of industrial cranes (high execution speed, ease of integration, low cost, low power consumption, less computer memory and good support with precise position visual guidance);
- scalability information, related to the display configuration and the ergonomics, by using and testing different screen types in crane cabins through case studies;
- risk indicators which are context specific (derived through the analysis of Serbian case studies) and operator-specific (which account for organizational and human factors by means of the response of operators to the questionnaire).
- techno-economical analysis of the proposed system.

The SPRINCE project is grounded on the idea that crane accidents caused by obstructed view and visual tension problems are preventable, thus it promotes a real-time computer-aided visual feedback and gives its assessment in the Industry 4.0 framework. General characteristic of survey participants are shown at Table 1. As the first phase, in order to check if crane operators need vision problems to be solved, 31 of them agreed (Table 2) to be asked two questions using the Likert scale 1-5: “Do you have enough visibility in all directions?” and “Is your view of the ongoing operation obstructed by obstacles?”.

Table 1. Crane operators sample characteristics

	N	Mean	Med	Min	Max	R	SD	c_v(%)
Age	31	45.226	50.000	28.000	55.000	27.000	8.958	19.81
Height	31	174.032	176.000	165.000	182.000	17.000	5.862	3.37
Weight	31	87.161	83.000	70.000	102.000	32.000	11.112	12.75
BMI	31	28.875	26.493	23.765	36.731	12.966	4.331	15.00
Working experience	31	20.065	22.000	5.000	32.000	27.000	7.298	36.37
Crane age	31	32.681	40.000	0.120	40.000	39.880	11.632	35.59

Remarks: N - number of crane operators, Med - median, Min - minimum, Max - max, R - range, SD - standard deviation, c_v - coefficient of variation

Table 2. Crane operators sample answers of interest

	N	**Mean**	**Med**	**Mini**	**Max**	**R**	**SD**	**c_v(%)**
Do you have enough visibility in all directions	31	2.968	3.00	2.00	4.00	2.00	0.706	23.801
Is your view of the ongoing operation obstructed	31	3.097	3.00	2.00	5.00	3.00	0.700	22.612

Remarks: N - number of crane operators, Med - median, Min - minimum, Max - max, R - range, SD - standard deviation, c_v - coefficient of variation

It is evident that crane operators do not have enough visibility (2.968 of 5) and that their view of the ongoing operation is obstructed by different objects and obstacles (3.097 of 5).

2. CRANES' VISUAL GUIDANCE SYSTEM

The Visual guidance system (VGS) is realized in SPRINCE project (Spasojević-Brkić et al., 2017a; Spasojević-Brkić et al., 2017b) as a real-time system dealing with different tracking systems. The system incorporates both a visual and an audio feedback, as integrated part of industrial cranes and it is designed with aim to prevent accidents due to obstructed view. The proposed system uses a colour web-camera in order to obtain the position of the hook (spreader bar) relative to the cabin and of the obstacle relative to the environment, to compute the distance between them and to create guidance commands to the operator for the feedback activation. VGS usage prevents collision and operator vision problems.
Real-time position measurements are obtained from the camera and displayed as a video on a monitor, which is also used to create the feedback to the operator. A camera is positioned within the working area of the crane, the video stream of the area is continuously processed by the statistical background modelling algorithm and, in case a moving object is detected in the scene, the system is warning the operator about its presence. To give the motion detection system also

has the ability to accurately estimate the real dimensions of objects and to calculate the distance between a moving object and the camera. In that aim the stereoscopic video acquisition methods are applied. The operator controls the load lifting on a laptop by means of software, while the computer communicates with the VGS by a remote desktop protocol (Milazzo et al., 2021; Ancione et al., 2020).

2.1. VGS installation in Serbia

The proposed system has been installed in two Italian (Milazzo et al., 2021) and one Serbian SME. It applies to all crane types and both on new and old cranes. In Serbia, VGS is installed on the bridge crane manufactured by Ivo Lola Ribar factory with a capacity of 63/20 t, structure group DIN H2B3, span 22m, lifting height 25 m, the speed of the main hook 5/0.5 m/min, auxiliary hook speed 6.3 m/min, trolley speed 16 m/min and the speed of the bridge 25 m/min. This case study has been selected because the crane serves many inaccessible places in the machine hall, which are out of the operator's field of view, as shown in Figures 1 and 2. This crane serves the machine hall, which has two levels. Field visibility for the operator on the first level of performance is not optimal. In contrast, in the second level below, the engine room operator has no visibility, but the work is carried out with the help of signalmen as support staff.

Figure 1. Selected crane in Serbian SME machine hall

Figure 2. Visual field of operator in Serbian SME

3. HUMAN FACTORS ANALYSIS AND VGS INSTALATION

In order to define the optimum real-time computer-aided visual feedback, besides the development of adequate software, many important things need to be considered, such as to monitor size and position, type of monitor, selection of keyboard or touch screen, selection of adequate resolution, etc. These decisions will depend upon different factors, including how quickly and with what precision the operator needs to see the information or pictures on display, does he need and how much data to entry into the device, what kind of configuration will provide him with the most comfortable working postures and the least tension in his vision...

As pointed out in Barron et al. (2005), the inadequate field of view can lead to decreased usage of capacity and properties of the machine, increased operators' health problems (due to awkward positions in which he operates because of the poor field of view) and, in the end, increased danger to both operator and the crew working near the machine. Thus, ergonomic design of operators' working space regarding any navigation system has to take into account the optimal location of machine displays and appropriate sized window space for the viewing of respective machine operations, as well as to analyze operator posture required to enhance task visibility while in a working position (Barron et al., 2005). Regarding the working position, at least eight basic anthropometric dimensions - standing height, sitting height, lower leg length, upper leg length, shoulder width, hip breadth, arm length and foot length, should be considere (Spasojevic Brkic et al, 2014; Essdai et al., 2018; Brkić et al., 2021; Brkić et al., 2015).

As graphical processing power of the PC has increased, flat panel displays became available in larger sizes and over time they are quite affordable (Ball & North, 2015). Never the less the most users still possess displays whose display surface area is less than 10% of their physical workspace area (Czerwinski et al., 2003).

To our knowledge, there hasn't been empirical research on the impact of display size on the crane operators' performance. Moreover, there are very few empirical investigations in the literature demonstrating real or perceived productivity benefits from using large displays (Czerwinski et al., 2003; Ball & North, 2015) in general. Even though many qualitative claims confirm the benefits of using a larger display while working, this is the case. Those studies that have investigated display size effects regarding human-display interaction all had the same conclusions. That is, the larger displays are better than the small ones. In contrast, crane cabins usually have enough space to accommodate larger screens.

For instance, Czerwinski et al. (2003) has examined several different displays models to examine whether a very large display influences human performance compared to traditional single-monitor displays. The survey goal was to start a process of identifying productivity benefits provided by interacting with very large displays for typical computing tasks. Significant benefits were found in the use of a prototype of a larger display, in addition to significant positive user preference and satisfaction with its use over a small size display. Users were significantly faster when working on the large display, finishing their tasks 11 seconds faster, which amounts to just over a 9% increase in productivity while working on the larger display. Moreover, 14 of 15 participants preferred carrying out the tasks on the larger display, and user satisfaction measures were significantly better for the larger display, too. However, this study didn't include different viewing distances or differences in screen resolution.

Another study examining the correlation between display size and productivity was conducted by Simmons and Manahan (2001). They used three different experiments and used a sample of 50 participants to determine the effects of display size on user performance and preferences. Parameters measured during experiments included time to complete the task, percentage of users attempting the task, percentage of users successfully completing tasks, and preference measures collected via nine-point bipolar scales. This study did involve evaluating the influence of different resolutions, and as a result, the authors recommended several resolutions for different display sizes

based on users' preferences and rankings. Results showed that users performed significantly less time on the larger display than on smaller ones. In addition, users ranked displays from least to most preferred one. There was a significant difference between larger and smaller displays, with former preference scores being much higher than later.
Another interesting example is research done by Johnsen et al. (2010), where mixed reality display configuration included a very large display with a life-size virtual human. It has resulted in significantly different behavior and important social dimensions compared to virtual humans presented on a typical LCD monitor. They emphasized that media psychology has already shown a strong positive correlation between imagery size and emotional response, in a way that humans have much stronger reactions while watching large displays. In order to comprehend how social constructs that author's chose could be affected by display configuration, the video recorded the verbal and non-verbal response behavior to a virtual human under these two fundamentally different display configurations.
Videos were evaluated by five evaluators who weren't aware of differences in displays that participants were subjected to. Results clearly showed that display configuration can strongly influence both cognition and behaviour and those designers should be aware of the limitations of small desktop display configuration.
Ball and North (2005) studied the effects of a large tiled display with a resolution of 3840x3072 compared to two smaller displays (1560x2048 and 1280x1024). They argued that there is not enough evidence that high resolution is a better option and to what extent, especially when users' task is to absorb a lot of information in a short time. There is evidence that large but low-resolution display and mixed density display that implements focus plus context by combining a small and large display, both at low resolution, have visualization advantages. However, displays with better resolution provide a larger view port. Hence, Ball and North (2005) experimented to determine tradeoffs between low- and high-resolution displays for basic low-level visualization and navigation tasks.

Participants were required to find various visual features within the large 2D space (2D virtual navigation is based on simple zoom plus pan interaction). Their time to complete each task was measured. Results showed that the larger configurations perform better than, the smaller configurations when dealing with finer detail data. On the other extreme, participants' performance time on the bigger configuration was less than half of the performance on the smaller monitor configuration. Interestingly, participants preferred zooming over the panning but chose not to interact with the mouse whenever they could, even when they had to squint to see the indistinct targets. This might be due to the fact that people do not like to lose the overall context of what they are doing, which is what happens when they zoom or span.

Overall, higher-resolution displays that use physical navigation significantly outperform smaller displays that use pan and zoom navigation with finely detailed data. Moreover, a larger display is less stressful and creates better confidence than smaller displays.

Considering all available information regarding display size, it can be concluded that a larger display could be a better solution for VGS installed in crane operators' cabin.

There are a number of studies dealing with the issue of choosing the best option for data input in innovative solutions such as the one proposed herein. Options vary from mouse keyboards to joystick and light pens. Sears and Shneiderman (1991) have made an interesting, deep comparison of touchscreens and mice for tasks requiring accurate selection of small targets. They concluded that touch screens are as fast and accurate as a mouse when selecting these small targets. On the other hand, while touch screens have been slower than standard keyboards for typing, there are situations where using a touch screen for data entry may be useful, for instance, when infrequent data entry is needed (Sears and Shneiderman, 1991). Therefore, when a keyboard can consume a lot of work space, a touch screen could be more appropriate without a real need. There is, of course, an obvious advantage when using touch screen keyboards, that is, the possibility for the user to choose the kind of keyboard that suits his personal needs and preferences the most. Different keyboards include QWERTY, Dvorak, French, Swedish, or any other keyboard the user wants. Most users are used to the QWERTY keyboard.

In the case of crane operators, they don't have a large amount of data to entry. Nevertheless, it is crucial that those entries to make be as precise, fast, and comfortable as possible. This is important because the operator has to stay focused on the load and everything around him while dealing with his navigation system.

In their work, Wallace et al. (2008) were concerned with content redirection, namely with the fact that content from one device is mirrored onto another, and input redirection in the sense of moving a user's control focus from one display to another, from a variety of seating positions in an MDE. They particularly analyzed the situation when the content of the shared display is redirected to a personal device to allow the user to easily view and interact with the content. To evaluate this, they used four different interfaces. Each used the keyboard or mouse to transition between displays and measured parameters such as task completion time, accuracy, workload, and preference. With keyboard transitions, redirection is activated by pressing a keyboard button, whereas, with mouse transitions, this functionality is triggered by moving the mouse cursor. The experiment consisted of the dock stage and a dialogue stage, and sixteen right-handed participants participated. Participants sat with the laptop and mouse on a table positioned approximately 6" from a large projected display. They found that, in the case of transitioning back to the local display, participants took significantly longer to transition when using the mouse than when using the keyboard and in the case of transitioning from the local display result was the same, but the difference was not statistically significant. For content redirection, using the keyboard was significantly faster than using the mouse.

Sears and Shneiderman (1991) investigated the use of touch screen keyboards for limited data entry. They analyzed several design issues, including key size and the location of touchable regions, to develop an improved touchscreen keyboard. This experiment included three input devices - a touchscreen, a mouse, and a standard QWERTY keyboard. When using the touchscreen and a mouse, a QWERTY keyboard was presented on the screen and data was entered by selecting keys on that keyboard. Each of the nine subjects (all familiar with all three input methods) were required to enter one practice string with each input device, and than used each device to enter six strings and this was repeated several times during several days. Typing times were converted to words per minute, assuming 5 characters per word. Results were as fallowing. The mean number of total errors was 0.9 for the mouse, 1.4 for the keyboard, and 1.8 for the touch screen. Mean typing speeds for the last trial are 17.1, 25.4, and 58.2 for the mouse, touch screen, and keyboard respectively. These results were in accordance with previous studies. What was encouraging here is that typing speed for the touch screen is considerably faster than what would be predicted from previous studies.

Interesting study was conducted by Brasel and Gips (2013) which was initiated by the fact that mouse-driven desktop computers are in many cases being replaced with touchpad laptops and touch screen tablets. They argued that touch screen interfaces can increase perceived psychological ownership, and this in turn magnifies the endowment effect. It is known that consumers respond better to products that have to be touched when used than to ones that don't. Authors hypothesized that relation of level of interface touch and psychological ownership is moderated by the importance of haptics for a product, in a way that products high in haptic importance have a stronger relation between touch and psychological ownership. Touch screen devices may have this effect even more pronounced than other products, as consumers have a sense of control because every touch executes their own command and it is known that perceived control is a key precursor and driver of psychological ownership In addition, touch devices such as smartphones and tablets have a more direct association with a consumer's extended self. In order to test their hypothesis authors conducted two separate studies.

One with a multi-interface computer in which levels of touch and product haptics were analyzed and other with laptops and tablets, in which conclusions from the first study will be supported by means of interface ownership. The first study showed that touch screen interfaces generate stronger levels of endowment when compared to touch pads and mice, as a result of phenomena of psychological ownership. The second study confirms the findings of the first one by showing that touch screens generate stronger levels of endowment when compared to indirect touch on a touchpad.

Taking into account available literature it can be concluded that, as expected, usage of keyboard is the best solution for the crane cabin, as entering the data is fastest on it, but study Sears and Shneiderman (1991) showed very interesting alternative. If for some reason standard keyboard wasn't appropriate, and there is now need for entry of large amount of data, as is the case with crane operator, touch screen keyboards are probably good option.

When the display size is defined the question of display position should be addressed also. Display position can directly affect performance and subjective workload, according to Wallace et al. (2008). There are several options to consider, whether it should be positioned vertically, horizontally or titled.

Forlines et al. (2005) conducted experiment to answer some of questions regarding display position and number of displays that are used for visual search. They emphasized that it is very important to understand in which manner single or multiple display, as well as vertical or horizontal positioning of the display, impacts human performance when performing their tasks. Their experiment involved groups of one, two and four people and three different display configurations. Display configurations covered included: a single vertical display (with participants sitting shoulder to shoulder in front of a single display which rested on a desktop at a comfortable working height), a single horizontal display (positioned horizontally at a height of 70cm with single participants sitting along the bottom edge of the display, pairs sitting across from one another and groups of four sitting at each side of the display) and four vertical displays (positioned in a row on the same desktop where single participants were seated in the centre of the four display, pairs in front of the centre of two displays and groups have each participant in front of each display.

Results from this study that are useful for present problem include finding that individuals show poor performance when dealing with multiple vertical display configuration. Results show that multiple configuration needs 30% longer time for searching stimulus than in single configuration. If this was accompanied with reduction in error rate, it could be consider as option, but authors did not find such reduction. With reflecting to those findings, it is decided that a single monitor is the best solution in crane operators' cabin.

Even though Forlines et al. (2005) have not found a significant difference in individual performance on vertical compared to horizontal positioned displays, some other research showed bad results with the horizontal display. For instance, Lawson et al. (2000) showed that a horizontal workspace could emphasize the foreshortening and distortion of images, which reduces performance in visual searching tasks. Therefore, it could be concluded that the display in the crane cabin should be positioned vertically, with the remaining question of mounting angle.

In another work, primarily concerned with the data entry into devices, Sears and Shneiderman (1991) also provided valuable information about the angle at which users prefer to work with touch screens. As previous research showed, such as Ahlström and Lenman (1990), different mounting angles of the touch screen can significantly influence users' performance and fatigue. In this study, users repeatedly performed simple menu selection tasks with the touch screen mounted at 90, 60, 45, 30, 22.5, and 0 degrees from horizontal. Results clearly showed that an angle of 30 degrees was optimal and caused less fatigue than others. Based on this and other similar studies, Sears and Shneiderman (1991) chose angles of 30, 45, and 75 degrees from horizontal (75 is approximately the standard monitor position).

The hypothesized that a 30-degree angle would result in less fatigue and be preferred by users.

Experiment was conducted on a ten computer science students and staff members at the University of Maryland who participated in the experiment, with six participants were already familiar with touch screens. Every subject was required to touch seventy small targets presented in a 10 by 7 matrix twice but without stressing restrictions regarding time or accuracy. Afterwards subjects ranked the three screen angles for fatigue and preference for extended use.

Authors found that there is significant effect of screen angle for both fatigue and preference, and results clearly showed that angle of 30 degrees was more preferable on both terms. As was expected, the 75 degree angle was rated as the most fatiguing and least preferred.

Analysis of these few studies clearly indicate that best option for mounting angle of the touch screen would be 30 degrees.

Barron et al. (2005) pointed out that previous literature suggested that warning displays should be within 301 of the normal line of sight or 451 for a ‘sit-stand’ working position, and secondary displays within 601 of the normal line of sight, while ergonomic guidelines require that a machine operator should have a free view of the operating zone without having to adjust posture. Therefore, they concluded that the operator should not have to turn their head more than 301 to either side, and that the head should not be tilted more than 51 up and 251 down for sustained comfort.

In their survey Wallace et al. (2008) explore four seating positions relative to the display, namely North, South, East and West position. They have found that users’ time to perform task is significantly affected by their position. Although participants were slowest to perform the task in the North position, followed by the West, the East and the South positions, post hoc analysis revealed that participants were significantly slower in the North seating position than the South seating position. South position, as expected, was the most preferable one. The west position has showed to be the next best option. In accordance with this study, as well as, with practical experience,

display in the crane cabin will be positioned in the south or west position.
Another aspect to be considered regarding input device in the crane operators' cabin, is the size of the keys. In most cases, the keys' arrangements and/or their sizes are significant factors influencing the operation efficiency (Michalskia et al., 2006). The appropriate size of the key on the keyboard will provide lover error rate and faster typing. Earlier studies (Hall et al., 1988; Gould et al., 1990) showed that targets 26 mm per side result in over 99% accuracy when users are sitting in front of the monitor while 20mm would be the lower limit for key size in order not to have too many errors.
These studies, however, didn't take into account touch biases which depend of monitor position. This problem was analysed in Sears and Shneiderman (1991) together with defining the optimum key size. They used the locations of all actual touches collected from experiment to calculate square keys and result was 2.61 cm per side. But considering the interaction between touch biases and key size they showed that correcting for biases allowed keys to be reduced from 2.61 cm per side to 2.27 cm per side while maintaining an error rate of less than 1%.
Computer users have contact with an information system only with the help of an interface that defines information flow rules between a human and a machine (Michalskia et al., 2006). Whenever new software is developed or when there is a need to choose among several existing software, for whatever purpose, interface is something that must be considered carefully. Michalskia et al. (2006) examined the effects of a computer screen interface design and its related geometrical characteristics. They were primarily concerned with point and click method which require usage of many available devices, for instance light pens, digitizers, joysticks, touch screens and most efficient tool of all, computer mouse. They wanted to show specifically how computer interface features impact the visual search task efficiency.

Some earlier studies showed, for example, that search time was shorter for the vertical than for horizontal menu configurations, as well as for the smaller number of items in the menu. Also it was proved that effect of icon quantity and quality considerably influenced search mean times. The first part of the Michalskia et al. (2006) research was to further investigate the problem of designing efficient graphical panels. 490 participants were included in the experiment with special-purpose computer application, designed by authors. They varied three independent variables, namely graphical object size, panel location on the screen and panel configuration, and measured two dependent variables - acquisition time and the number of errors made.

There were several conclusions from this experiment which overall confirm that geometrical factors significantly affect operational efficiency in the visual interactions of a human–computer interface. The operation was shown to be shorter when graphical objects are larger. Also, it was shown that graphical structures composition had a significant impact on operation efficiency, as configurations of nine rows and four columns had shortest time of operation and vertical orientation, consisting of two columns and 18 rows had longest. Panel location had no impact. The total number of errors did not exceed 1.7% on any of the trials and authors found this generally consistent with other studies.

Authors concluded that as a general rule small graphical items should be avoid in interface design, however they emphasized one should search literature in order to find if there was a research of an optimum of item size. Also they advised that, if square configurations are not applicable, compact horizontal panels should be used and vertical arrangements should be avoid complete.

Even though it is known that human performance is affected by numerous factors, complexity is considered the most influential factor that affects the human-system interaction (Ham et al., 2012). Considerable contribution to this topic was provided by Ham et al. (2011a), whose work deals with the solving of problems related to the complexity of the interaction between humans and modern socio-technical systems, which also include the innovative solution for operating cranes developed in this project. Ham et al. (2011a) emphasized that, even though numerous studies have dealt with researching of complexity factors that affect the cognitive abilities of humans interacting with the system, there was still a lack of a systematic approach to determining of these factors, and thus have developed such an approach themselves.

The more complex the system (more details, functions, possible choices etc.), the weaker are its performances, especially those related to the strategy of the mind, use of cognitive resources, acquiring of cognitive skills, work overload and human error. However, the term of human-system interaction complexity itself is not clearly defined, i.e. there is a variety of different definitions which can be distinguished according to the criteria from which they were derived (Ham et al., 2011a). Unlike the majority of researchers, Ham et al. (2011b) focused on the problem of finding and organizing the complexity factors in a systematic way, which can be applied in any context.

In earlier literature (Vicente, 1992), a different number of complexity factors is defined, and is considered to provide an adequate description of a complexity of a system. It is also mentioned that these factors include both subjective characteristics related to human knowledge and objective characteristics related to the technical solutions of the system itself. In this sense, it can be concluded that the complexity of the system can be reduced by providing humans with adequate and sufficient knowledge and skills related to that system.

Objective system complexity can be measured quantitatively and is possible to reduce by means of technical corrections of the system. Actually, design of the interface, as a part of the system design itself, must be based and focused on the human, for the purpose of taking advantage of technical innovation, enabling of optimal human-system interaction and enhance the ability of humans to interact with their surrounding, as was concluded in the paper by Carvalho et al. (2008). It is clear that these two types of complexity, namely subjective and objective one, are connected one to another. The complexity of the task which needs to be performed itself is considered as the connection between the task input and output relative to human capacities, capabilities and limitation, and namely it is considered to be on the border between objective and subjective complexity. In their paper, Ham et al. (2011a) mention that there are various other complexity factor categorizations, such as by their structural complexity, functional complexity and interface complexity, or more detailed categorizations which include multiple levels or layers within which different factors are distributed.

Numerous researchers were focused on defining the factors related to cognitive tasks complexity. In addition, a number of papers (Ham et al., 2012) involved the identification of complexity factors for a given system. However, a method or a structured framework according to which factors of human-system interaction complexity could be identified and organized for any given area was not developed in any of these researches.

In their paper, Ham et al. (2011b) have developed a model for identifying and organizing of complexity factors, by observing the problem in an abstract and holistic manner, through eight different views. In this way, the requirement for every view was defined, and a conceptual framework consisting of five such views was suggested. Each of these views provides individual unified dimensions for identifying and organizing of complexity factors. Design view is related to complexity factors which occur during the designing of the system, such as, for example, the number of objects that appear on the interface. These factors can be influenced by the designers themselves.

Design view describes which types of knowledge are necessary to have and use in order to interact with the socio-technical systems. Design view includes the following types of knowledge: about the area (system) in which the work takes place, about the task, strategy, cooperation, as well as cognitive knowledge and knowledge within the interface. Knowledge view is the focus of this model, since all other views are related to it.

Since the knowledge view is defined as the most significant one within this concept, the authors have developed a model of complexity factors based particularly of the knowledge view, and this view will be adopted as representative in the case of the interaction between the operator and the visual control system for industrial cranes. As was explained by the authors, all view can be used for all process activities. However, it is considered by them that using only the knowledge view is efficient enough. In that sense, the knowledge view is related to knowledge necessary for the operator to posses in order to successfully use an innovative visual system for crane operation to avoid accidents. The suggested complexity factor model requires the distinction between the aforementioned six knowledge types, and besides that, each of them is identified according to three different aspects: spatial, relational and temporal.

Spatial aspect of knowledge complexity is related to a number and type of elements of which it consists, which defines the subject and scope of the knowledge itself. Relational aspect of knowledge complexity is related to functional relations between given elements. Temporal aspect is related to the change in elements over time. Shown in table 1 is the example of the process of identifying of complexity factors. From this table, two factors related to the spatial aspect of knowledge can be seen: "Range of functional abstraction level" (for example, a process control system is generally characterized by 5 levels of functional abstraction, and if it was assumed that a system has 3 levels that the operator needs to use in order to perform a given task in the system, the value of this factor would be 3) and "task structure and necessary action steps" (if we were to assess that the operator requires 8 different actions-steps to perform their task, than the value of this factor would be 8).

Based on what was presented in previous research in context of VGS installation, it can be concluded that the developed model can represent an effective tool for the conceptualization of system complexity, as well as for identifying and organizing of complexity factors in the innovative solution for a visual control system for industrial cranes. As an aid in the very beginning of the process of identification of complexity factors, one can utilize a list of factors, such as:

- the size of the problem space,
- the variety and the number of functional elements/components,
- the component types and their connections,
- the rate of change of component states,
- the number of connection (between components)/degree of interconnections,
- the number of system goals,
- the goal compatibility and limitations,
- the uniformness and heterogeneity of the workspace,
- the number of mutual nodes,
- the number of processes per node,
- the signal/noise ratio,
- the system and subsystem hierarchy,
- the number of system tasks and relations between them,
- physical and psychological strain during performing of the task,
- the task uncertainty,
- the number of steps that must be undertaken in order to complete the task,
- the amount of information which must memorized during work (short-term memory)
- the amount of information from existing knowledge which must be used (long-term memory).

4. ORGANIZATIONAL FACTORS ANALYSIS AND VGS INSTALATION

As the most important organizational factor leadership and administration style effect on safety issues when using innovative VGS in cranes transportation tasks has been examined using the questionnaire survey.

Thien et al. (2007) also emphasize the importance of organizational factor assessment, noting that occupational safety and health measures have impact on equipment integrity, and suggest some modifications to the approach defined in standard API 581 (2000).

Noori and Price (2006) state that the procedure according to API 581 (2016) standard is not applicable to all types of plants and equipment, pointing out the example of boilers, such as lack of data on failure frequencies, inspection intervals, etc., so novel instrument adapted to cranes specificities is needed. Similar to the experiences of Noori and Price (2006) and Thien et al. (2007), which propose changes in the field of application for specific process equipment, we believe that crane transport systems require a significant change to the questionnaire proposed in API 581 (2016).

Accordingly, the following questions based on the previous research, but with adaptation to crane systems have been used, and scaled to 15 points at maximum:

1. Does the organization at the corporate or at your organizational unit local level have a defined role (commitment) of management in policy of the process safety management?
2. Is the general policy statement:
   a. Contained in manuals?
   b. Posted in various locations?
   c. Included as a part of all rule booklets?
   d. Referred to in all major training programs?
   e. Used in other ways? (Describe)
   ....
3. Are responsibilities for process safety and health issues clearly defined in every manager’s job description?
4. Are annual objectives in the area of process safety and health issues established for all management personnel and are they than included as an important consideration in their regular annual appraisals?
5. What percentage of the total management team has participated in formal training courses, symposia and conferences or process safety management seminars and educations, over the last three years?

6. Does the Safety Committee or something similar exist in the company or on facility level?
    a. Are the committee members from different organizational units and of different educational levels?
    b. Does the committee meet regularly and document that appropriate recommendations are implemented?

The questionnaire was sent by e-mail in 60 companies in Serbia, that are using the crane systems (crane and cabin) and which have potential and need to use VGS. Although official data is not available, the population of enterprises with crane systems, according to the authors of this survey, and five experts that have participated in Delphi method, is not significantly higher. After sending three emails (two reminders to answer the questionnaire) during the three months, 51 companies have responded (with an average of 122 employees). Accordingly, response rate was surprisingly high.

There has been an unexpectedly high response to this survey, 85%, indicating a very high level of interest in solving problems regarding crane systems. The average number of employees in the surveyed companies was 159.85 with a standard deviation of 247.12. The survey was completed by experienced staff, with an average of 18.25 years of work experience. Namely, 73% of respondent companies are certified according to ISO 9000, 47% according to ISO 14000 and 51 according to ISO 18000, while 42% of the companies in the sample have an integrated management system for all three standards.

The following descriptive statistics has been obtained, as in Table 3.

Table 3. Descriptive statistics on Leadership and Administration factor

Question	Mean Value	Standard Deviation
1	5.263	1.939
2	6.474	1.073
3	5.158	1.803
4	5.368	2.629
5	2.263	1.939
6	10.684	3.267

Later on data were undergone to factor and reliability analysis.

Table 4. Factor Loadings

Factor Loading (Varimax raw) Method: principal Components (Significant >0.7)		
	Factor - 1	**Factor – 2**
1	**0.909497**	0.230833
2	0.227385	0.566211
3	**0.849636**	0.366442
4	0.365379	**0.816443**
5	-0.036865	**0.915199**
6	**-0.933099**	0.130197
Explained Variance	2.606306	2.029278
Percent in Total Variance	0.434384	0.338213

Data in Table 4 show that questions are grouped in two components, as expected, since construct covers both leadership and administration. Also, taking into account the fact that question 1.2 does not have enough high loading is important.
The analysis in Table 5 shows that the ejection of question 1.6 (related to Safety Board) increases reliability coefficient of the scale Cronbach alpha for the construct to the desired value greater than 0.70, i.e. 0.81.

Table 5. Reliability analysis

Mean value=27.7451 Std.Dv.=5.48030 N:51 Cronbach alpha: -0.14099
Standardized alpha: ,477939 Average Correlation.: ,176886

	Mean value - after deleted	Varijance - after deleted	StDv. - after deleted	Correlation	Alpha - after deleted
1	**22.27451**	**26.82660**	**5.179440**	**-0.085073**	**0.000000**
3	**22.47059**	**24.64129**	**4.964000**	**0.121636**	**0.000000**
4	**22.49020**	**15.54402**	**3.942591**	**0.561568**	**0.000000**
5	**25.70588**	**16.83506**	**4.103055**	**0.702309**	**0.000000**
6	18.03922	37.25336	6.103553	-0.499034	0.809473

5. ECONOMIC APPRAISAL OF VGS

In this part, the feasibility of purchasing and installing visual systems (VGS) and monitoring of the work of the crane in a real time is assessed economically (Brkic et al., 2020).

In the scenario of the assessment of the VGS, the initial investment costs include hardware purchase costs (2 Wi-Fi cameras OpenNI type, 1 Remote control, 2 Portable power pack 10400 mAh, 2 MicroSDXC Memory Card 64 GB, 1 Computer, 2 Raspberry pi 3) and software costs, equipment and program installation costs, adjustment costs for the existing cab and initial training costs. In the model of assessment of the economic feasibility of installing the VGS for the detection of the environment in the existing cabin and the existing crane of smart cranes, the initial investment costs range from 5 800 to 8 900 euros, depending on the characteristics of the equipment.

In our conservative estimate, the initial investment cost is 7 400 euros. Starting from the assumed lifespan of the crane (17 years old), in the eighth year, a complete replacement of hardware is planned, which evaluates the treatment of a new investment cost. Additional operating costs that entail the installation of VGS system in the cabin of smart cranes for the process industry include hardware and software maintenance costs, increased labor costs, additional electricity costs that implicate the exploitation of a VGS system and other dependent operating costs (Table 6).

Table 6. VGS costs

Investment Costs	EUR
• Hardware costs	5 900
• 2 Open-type Wi-Fi cameras	
• 1 Remote control	
• 2 Portable power pack 10400 mAh	
• 2 MicroSDXC Memory Card 64 GB	
• 1 Computer	
• 2 Raspberry pi 3	
• VGS Software costs	1 000
• Costs of VGS installation, testing and training	500
Additional operating costs	
Additional labor costs	1 800
Costs for software maintenance and additional costs of electricity	100

The total net savings resulting from the usage of the VGS are € 6 776 per year (Table 7).

The net present value of the installation of VGS is 26 828 euros for a 17-year exploitation period and at a discount rate of 10%. According to this criterion and with very conservative estimates of the discount rate, the project is economically justified.

The internal rate of return of the project for the installation of a VGS on the existing crane is 65%, and this rate is several times higher than the discount rate, which means that solutions are economically justified.

Table 7. VGS benefits

Benefits / year	EUR
Savings in more efficient use of crane	2 494
Savings in labor costs $$LSC_t = n \cdot h_t \cdot w_h \cdot \rho_t$$	1 440
Annual savings due to reduced incidence of professional diseases and injuries of crane operators $$LSDC_t = n \cdot Dh_t \cdot w_h \cdot \rho_t$$	441
Reduction of the crane maintenance and repair costs $$MRSC_t = PC \cdot \left[\frac{MRC_t^1}{PC} - \frac{MRC_t^2}{PC} \right]$$	1 652
Reduction of annual depreciation costs $$ELSC_t = PC \cdot PMT_n^i - PC \cdot PMT_{n+m}^i$$	750
Total	**6 776**

7. CONCLUSIONS

The literature has highlighted the main needs for crane design such as capability to be safely operated, easy maintenance and reduction of typical human problem factors, but up to now, worldwide research has not been focused on the crane navigation system. It seems that solution given in project SPRINCE (Spasojević-Brkić et al., 2015) is one of rare steps, which brings cranes closer to Industry 4.0 concept.

In order to define the optimum real-time computer-aided visual feedback, beside the development of adequate software, there are many important things that have to be considered and examined. Issues are starting from human factors such as such as monitor size and position, type of monitor, selection of keyboard or touch screen, selection of adequate resolution, over organizational factors such as those

connected leadership and administration style and finally economic appraisal is also very important. This paper covered those aspects of implementation of VGS in Serbian context.
It has been concluded that human factors have to be such as given in Table 8. Interface also has to adapt to the best possible usability features, such as in Figure 3.

Table 8. Human factors for VGS

Factor	Choice	Notes
Display size	2 dimensions • 29.7x21 cm (laptop) • 19x12 cm (tablet 7")	-
Display Resolution	• Any kind of laptop • 1280x752(800) or 1024x600 for tablet	Non influential for laptop if display is available with the use of pan and zoom navigation
Data entry	• Keyboard QWERTY or touchscreen • Mouse or touchscreen	Depending on display option for laptop QWERTY and mouse an for tablet touchscreen
Display position	30^0	-
No. of displays	Single	-
Seating position	South or West position	-
Key size	2.27 cm	For touchscreen option
Software influence	Computer interface features: • Vertical menu configuration • Large graphical items • Small no. of items in menu • Horizontal panels	-

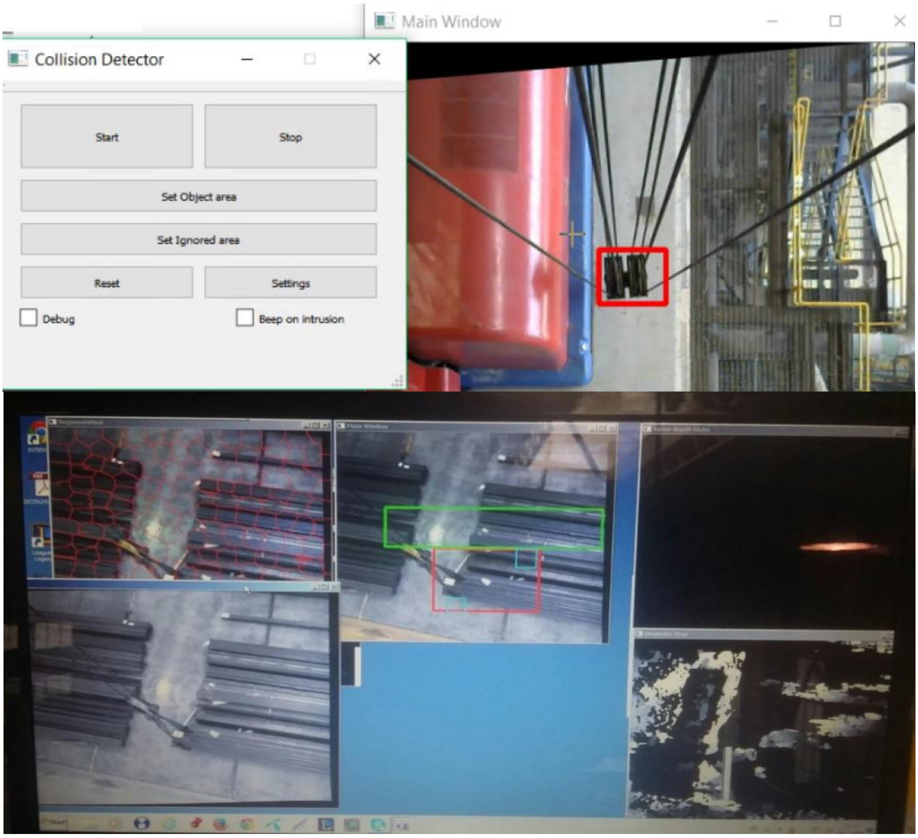

Figure 3. VGS interface

Also, it has been shown that special attention has to be paid to the following organizational factors:

- Commitment of management in policy of the process safety management.
- Safety policy statements have to be contained in manuals, booklets, training programs and to be posted in various locations.
- Responsibilities for process safety and health issues have to be clearly defined in every manager's job description.

- Annual objectives in the area of process safety and health issues have to be established for all management personnel and are included as an important consideration in their regular annual appraisals.
- Top management team has to participate in formal training courses, conferences or process safety management seminars.

It is evident that this paper opens numerous novel research avenues, since crane cabin modernization could be applicable in different machines which have cabins and similar visual problems, beside cranes, such as bulldozers, excavators, loader etc. Also, further VGS improvement is possible, since it is still in prototype phase. VGS integration with other industry 4.0 solutions in the factory is one more possible direction of future research.

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EMPLOYEE AGILITY TO THE CONDITIONS AND CHALLENGES OF ECONOMY 4.0.

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Abstract

The chapter deals with the problem of the company's adaptation in a turbulent business environment, which provides the company with new challenges. A company that wants to meet them should develop new agile features that allow it to survive in a turbulent environment. The chapter presents a model of the functioning of an enterprise, equipped with agile features, developed as a specific response to contemporary market challenges. These qualities have been defined as acumen, the ability to prepare an offer to meet the changing demands of individual customers, operational agility and leadership, accompanied by the ability to create an agile vision and mission.
Keywords: *Agility, Economy 4.0, Enterprise, Smartness, Market environment*

1. INTRODUCTION

This document is a template. The development of the concept of agility has become the response of modern enterprises to unpredictable, turbulent and uncontrolled changes in the business environment, which are the result of the challenges of economy 4.0. Changes can be treated as an impulse to create the function of change in the environment, characterized by galloping digitization and digitization. A company that wants to survive must create the ability to respond strategically to the emerging new criteria of the business environment. This means the need to use an integrated information system (as part of agility relays), which would ensure the highest timeliness of data, as well as effective communication and data richness, etc.

The emergence of integration processes in conditions of market instability, turbulent environment, rapidly deepening globalization, the growing importance of interdependencies between economic entities, and above all the progressive digitization and digitization are factors that imply very difficult challenges for modern enterprises, and thus for their employees. In order to survive, organizations are forced to be more cautious, evolve their behavior, strengthen their strategic thinking skills and react quickly to emerging market threats. They must therefore develop the attributes of agility. These features play an important role in the process of achieving market success, and at the same time strengthening the competitive position of a modern company.

The author of this chapter raised the issue of employee agility as a kind of response to the challenges arising in connection with the functioning of economy 4.0. The aim is therefore to analyse the problem of agility and its features as a response to new phenomena emerging in the turbulent economic reality and to present such employee characteristics that will allow to cope with an unpredictable environment and market environment.

The chapter is an attempt to detail the features of employee agility that significantly improve its functioning of the modern organization and allow it to survive in a turbulent, unpredictable environment. To this end, the agile characteristics of the organization's employees were identified in the context of the challenges of modern enterprises, arising from the conditions of rapid digitization and digitization, which are the determinant of economy 4.0. A model of the enterprise was constructed, bearing the attributes of employee agility.

2. TURBULENT MARKET CONDITIONS AS A CHALLENGE FOR MODERN COMPANIES

The environment of the twenty-first century can be described as chaos. The mere use of the word chaos can replace the further definition of its specific features (Munodawafa & Johl, 2019). The name chaos, in the deterministic sense, was introduced as a mimetic description after mathematics and physics. This happens primarily due to the insufficient number of terms that reflect the nature of the environment. Small, often unrecognized changes in the environment can cause disproportionate effects on the organization. Although such a model is described as deterministic, it behaves like a random one (Baker & Gollub, 1998.; Ott, 1997; Mika & Zeug-Rib, 2016).

Companies must therefore be aware that of the two complementary images of the world: order and chaos, the latter dominates (Warnecke, 1993). This has huge consequences for the functioning of modern enterprises. Another euphemism that replaces the exhaustive characteristics of the environment remains turbulence. This phrase describes the “complex” behaviors of the environment, the flows of events that make the previously ordered sequence of events unstable (Sull, 2009).

Turbulence entails a series of profound and unpredictable changes in the functioning of the environment, increasing complexity and growing competition, as well as through the high dynamics of changes, associated with the consequence of implementing new solutions on the market at an extremely fast pace, with such a scale of novelty that maintaining a competitive advantage in the long term remains very difficult, or even almost impossible Sallnäs & Björklund, 2020).

In conditions of a constant sequence of changes, competitive advantage becomes fleeting. Only those entities that are able to adapt most accurately and effectively to new environmental conditions have a chance to survive. The result is a change in barriers to entry and a change in market leaders and structural imbalances. The usefulness of tools that can be used to create favourable sectoral and market conditions for dynamic companies is increasing. The modern business environment is also characterized by the emergence of a role-conscious customer (Ritzer & Miles, 2019).

Thus, when characterizing the contemporary environment, the following remain permanent features: dynamic changes, gradation of their complexity and a diverse way of acting on various entities. The need to face the coming future forces its anticipation. A company that formulates its development assumptions and creates its operating strategy should take into account external and internal factors that significantly affect its development direction (Munodawafa et al., 2019).

Contemporary challenges related to the functioning of economy 4.0 give rise to new challenges. Companies operate in an extremely competitive and turbulent global market environment (Nath & Agrawal, 2020). Phenomena such as progressive digitization and digitization, the rapid pace of innovation and technological development, increased customer expectations for non-standard products as well as fragmentation of markets lead to extremely turbulent and at the same time rapid changes in the business environment. The question of how companies can successfully cope with an unpredictable and ever-changing market environment has become one major problem in industry and science (García-Granero et al., 2020).

The operating conditions of modern enterprises are usually referred to as the "new normal" (Kotler & Caslione, 2009) and "late modernity" (Giddens, 2007), in which the identification of cycles of economic development is not a method of meeting unexpected and unpredictable forces. This is not possible because strategic problems and ways of solving them have changed.

The conditions for the functioning of the digital economy determine the possibilities of operation and development of the company. However, modern organization is not able to make changes to these conditions. Although there are exceptions to this rule, in a situation where large enterprises with great potential and huge market

influence can sometimes influence the designated elements of the macro-environment (Mika & Zeug-Żebro, 2016).
On the other hand, all economic entities with cooperative or competitive links with the enterprise remain a competitive environment. Among the most important components of the competitive environment are suppliers, buyers, as well as existing and potential competitors (Gierszewska & Romanowska, 1996). Employees who had to exist in a constantly changing environment also had to face various challenges. Employees should develop the ability to think strategically, which means a fundamental change in the approach to strategic management, as well as adopting a specific perspective on potential events embedded in the future, as well as preparing the company to meet various strategic plans (Duczkowska-Piasecka, 2013).
Mun compares this perspective to "helicopter view" (Muna, 2010). Such a perspective makes it possible to analyze the functioning of the enterprise from the point of view of the environment and operating conditions. Anticipation of such factors becomes extremely useful for the management of the enterprise, which is able to realize the depth and state of changes in the environment and in its own organization. The goal of strategic management remains both the ability to achieve long-term security of the organization and the focus on the correct diagnosis of opportunities in the interweaving of random phenomena. That is why it is so important to recognize the probability of various events occurring, as well as the ability to create a market opportunity (Trzcieliński, 2013).
The conclusion on the characteristics of the business environment and its impact on strategic management certainly remains different from those claims that imply the passivity of enterprises in the face of market events. It remains extremely important that the relations of enterprises with their environment are subjected to constant analysis. These couplings should be considered, among other categories, as determinants of innovation, competitiveness and entrepreneurship. Functioning in turbulent conditions makes it

debatable to determine the reasons for the effectiveness of business management. However, the attributes of the environment, understood as variable, complex and unpredictable, have become the germ of doubts regarding the issue of analysis in the environment-enterprise relations and determinants determining its success.
The modern environment is characterized by many features. These include dissonance: on the one hand, the need to guarantee the stability of the company's operation, and on the other hand, its constant volatility. Sometimes this volatility translates into changes in the operations of enterprises. These changes, in turn, remain a derivative of the need to manage in a way that takes into account the variability, complexity, unpredictability and chaos of the environment (Witt & Mayer, 2007).

3. THE CONCEPT OF ENTERPRISE AGILITY

In the literature on the subject, the concepts of agility have been interpreted in various ways: in many publications they are interpreted as the ability of the company to quickly deliver a product, fully adapted to the needs and expectations of the customer (Munodawafa et al., 2019).
Agility is also understood as the concept of survival and the ability to cope in a competitive, turbulent environment, characterized by rapid digitization and digitization. These changes force a quick and effective response to market changes. To this end, the company has to meet the requirements of customers in a dynamic market. In addition, the organization should take quick action to ensure that it maintains its competitive advantage. Therefore, it introduces product, process and non-technological innovations, information and communication technologies. These activities will require reorganization and the formulation of new marketing strategies (Gunasekaran, 1998).
The concept of agility is also understood in the aspect of adaptability in a changing environment and proactive actions taken by the company, as well as flexibility and quick response. These activities

also include the acquisition of skills useful to ensure strategic and effective activities and continuous, intensive learning (Meredith & Francis, 2000). Such dynamic skills can be interpreted as the ability of an enterprise to achieve a competitive advantage, thanks to rapid and proactive, and at the same time identifying opportunities and upcoming threats (Bessant et al., 1999).

An agile enterprise is one that immediately responds to opportunities and threats arising in the environment. Opportunities in this context are situations that pass quickly, which is why their rapid use means achieving the desired effects and goals intended by the company (Trzcieliński, 2007).

An agile enterprise used to be described as “undergoing change” and quickly and easily adapting to it. Agility can therefore be defined as a feature of the enterprise, defined as the ability to make effective changes in the process of operations, processes and business connections in response to a constantly changing situation, in the environment and inside the organization (Hormozi, 2009). Gaining a sustainable competitive advantage is a consequence of both the resources and external factors outside the company, or even outside the sector in which it operates (Lisiński, 2005).

A company that effectively responds to the challenges of the environment should have the ability to develop a quick response to diverse demand patterns. It should also aim at effective customer and market orientation, properly diagnose the needs of the target audience and create closer relationships with the customer (Sambamurthy et al., 2003).

The agility of the company is manifested on several key levels. An agile company should always remain close to the market and the final customer, be provided with flexible operational potential, remain characterized by strategic leadership, effectively cooperate with suppliers, and - which is in line with the assumptions of economy 4.0 - use IT systems supporting management. A company that is focused on the final customer should choose one of two varieties of orientation: a concept related to product development and a second orientation, involving the customer in the strategic process of enterprises (Liao & Subramony, 2008).

Orientation related to product development, based on the proximity of the market and the customer, requires continuous research on the level of customer satisfaction and on the basis of the conclusions drawn, the desired product is designed. Then it is delivered in a completely safe way to the final customer while guaranteeing him a friendly and instantly responsive after-sales service to his needs (Munodawafa et al., 2019).

These activities are part of the traditional way of implementing effective marketing. However, the concept of an agile enterprise implies more sophisticated marketing activity. This is due to the inclusion of the final recipient in shaping the organization's strategy. According to the position of Alvin Toffler – the assumption of the concept of an agile enterprise remains the abandonment of treating the target recipient as a consumer, in favor of the need to see him as a prosumer (Veen et al., 2020).

When analyzing the concept of agility, one should consider whether the concept of an agile enterprise will become a completely new doctrine in management in the era of economy 4.0? This dilemma could be solved like this: in a situation where the doctrine of management is defined as a set of principles, systems and methods, understood in terms of the desired way of managing an enterprise functioning in the environment of economy 4.0, and when this doctrine is derived from precise theoretical premises, it is probably possible to judge the emerging new theoretical concept. At the core of the agile enterprise concept is the observation of the evolution of sources and maintaining a competitive advantage, with a turbulently changing market environment. The theory of enterprise agility is a set of guidelines for managers of a modern enterprise, functioning in conditions of progressive digitization. The key strategic problems that the company's management faces are then evolving and changing. Therefore, the description of the strategic problem situation remains different. The theoretical justifications for exemplary business behavior are also different.

4. AGILE CHARACTERISTICS OF EMPLOYEES OF THE ENTERPRISE

In the past, theories were formulated according to which agility and reaction speed were determined by the use of advanced technologies, which included computer-integrated manufacturing (Youndt et al., 1996). However, recent empirical research results unequivocally indicate that agility depends mainly on the characteristics of human capital, and not, as previously thought, on technology (Upton, 1995). Thus, organizational agility, agile production and lean production require the employee to develop specific features that should characterize agile workers.

Certainly, employee agility gives the company an impressive range of benefits, which include improved product and service quality, a better organizational culture, faster acquisition of knowledge by organizations, as well as more effective customer service (Herzenberg et al., 1998; Hopp et al., 2004). The development of agile qualities of employees becomes a determinant of achieving organizational agility. Employee agility can therefore be considered as the ability to respond quickly to changes taking place in the internal and external market environment, as well as the ability to properly use these changes and create new opportunities arising from their occurrence.

Turbulent market conditions in the business environment and labor requirements imply the development of agile behavior. These include (Belz & Barbasz, 2014):

- the ability to instantly see market opportunities,
- quick recognition of threats from the environment,
- efficient implementation of tasks and ongoing control of the implementation of these tasks,
- the ability to categorize the situation in the context of opportunities and threats,

- efficient compilation of "visionary with operational management", meaning the ability to spread ideas and embed them in the activities of the organization,
- correct assessment of the adequacy of resources and the possibility of obtaining them from the environment.

Veen adds more (Veen, 2020):

- the ability to adapt to the requirements of new equipment,
- the ability to adapt to work with a team practicing other methods of work,
- simultaneous work on several projects,
- adaptation to new working procedures,
- maintaining good relations with people from different departments.

In addition, Doz and Kosonen among the agile features still distinguish (Doz & Kosonen, 2008):

- the ability to reconfigure business systems,
- total commitment of the team interpreted in terms of skills of teams at high levels of management,
- efficient decision-making of important decisions for the organization,
- strategic sensitivity, understood as the sharpness of perception of consciousness and attention. A graphical visualization of the essence of employee agility is shown in Figure 1.

Breu and others specified indicators of employee agility, such as: speed of development of their own skills, speed of response to external changes, speed of adaptation to new working conditions, assessment of skills, speed of introducing changes, speed of access to information, independence of the workplace, use of mobile technologies, mobile access to information, work in virtual teams, knowledge sharing and collaborative technologies (Breu et al., 2002).

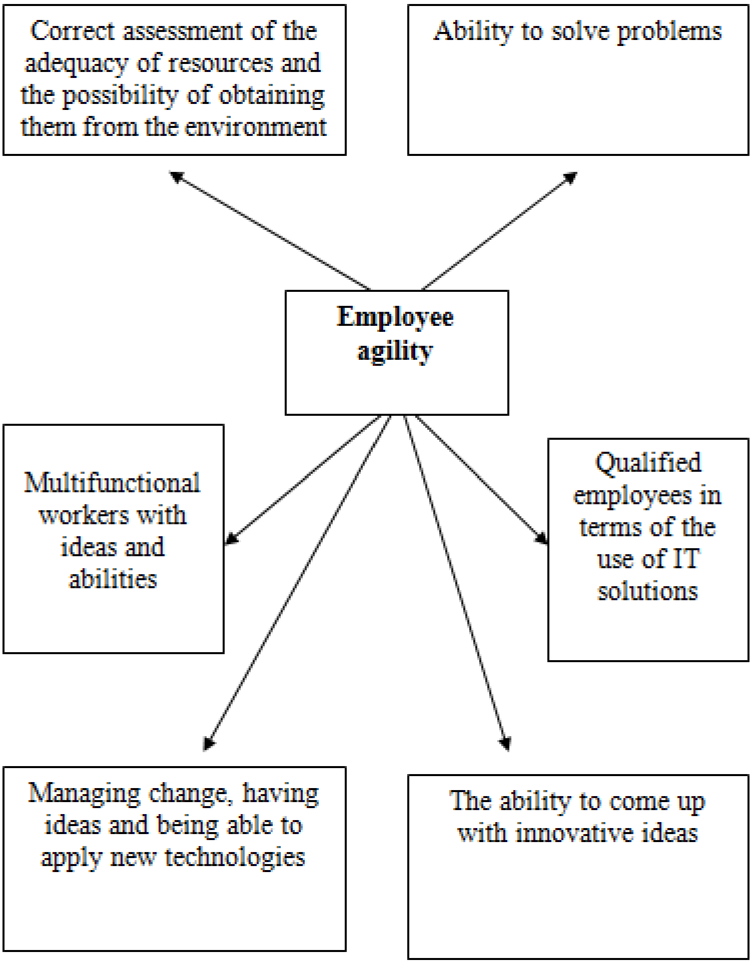

Figure 1. The essence of employee agility
Source: Own study

Sharifi and Zhang (Sharifi & Zhang, 1999) made the characteristics of agile employees according to four categories, shown in Table 1.

Table 1. Classification of agile employee characteristics

Agile employee qualities	
Compensatory	Effective and effective implementation of the organization's goals; includes an extensive list of skills, providing the enterprise with: excellent performance, productivity, effectiveness in achieving goals
Ability to react	Ability to identify changes and react quickly to those changes, to introduce reactive or proactive actions
Flexibility	Ability to implement new processes
Adaptability	Ability to complete planned goals in the shortest possible time

Source: Sharifi & Zhang, (1999)

Putting the employee in front of the need to adapt to changing market conditions, adequate to the functioning of economy 4.0 forced him to constantly evolve his behavior, which made him qualified in terms of using IT solutions. An agile employee is able to cooperate in a team, speaks many languages, acquires the ability to negotiate and apply advanced production strategies and technologies (Gunasekaran, 1999).
Therefore, no one needs to be convinced that employing an agile employee brings many benefits to the company, which include improving the quality of products and services, accelerating the company's ability to acquire knowledge, more effective customer service and a better organizational culture (Herzenberg et al., 1998; Van Oyen et al., 2004).

5. CHALLENGES POSED BY THE COMPANY IN THE ERA OF INDUSTRY 4.0.

The rapidly advancing digital transformation, taking place in the era of revolution 4.0, contributes to global development. Organizational challenges are shaped by this revolution, the ideas of which permeate all modern enterprises. Organizations have been forced to face state-of-the-art technology, covering an increasing number of industries. This technology significantly affects the volume and quality of production and the functionality of products (Veen, 2020).

Industry 4.0 introduced leading IT solutions in all aspects of production, allowed the creation of not only specific products, but also entire integrated value chains. Through the use of advanced ICT technologies, production is extremely precisely matched to customer expectations. This process takes place while maintaining low costs, high quality and efficiency. The methods of doing business, the functioning of enterprises and the structure of the market are rapidly changing. These processes are accelerated by new business models and technologies such as artificial intelligence and additive manufacturing (Ritzer & Miles, 2019).

Technological innovations in the form of new models of phones, computers and software are constantly emerging, so that the function and use of new goods should meet the expectations of future users. The same applies to management information systems. In highly developed countries for many years, computer-aided management methods play a large role in the field of business management. These systems quickly penetrated into various areas of business management (Pręgowski & Juza, 2011).

ICT technologies are developing dynamically, and the effective use of information remains a measure of a company's ability to stay among the competition. Thanks to it, you can react in an instant to turbulent changes in the environment. The company must have the appropriate equipment and system to analyse such information. The use of ICT technologies is part of contemporary business management concepts. The modern strategy of survival of the company on the market assumes offering the highest quality of customer service and striving to cooperate with it, also thanks to the use of ICT tools (Raišienė et al., 2019).

This translates into an extension of the functionality of IT systems, thus covering the company's activities as well as customer relations (Eden, 2017). Modern organization has come to function in the described reality. All its components should therefore fit into it, including the organizational culture. New specialist vocabulary is emerging, and thanks to dynamic digitization – new ways of communication. Employees have increased access to data that is growing exponentially from year to year (Matschke et al., 2013).

6. AGILE EMPLOYEE IN THE FACE OF THE CHALLENGES OF ECONOMY 4.0 – A MODEL APPROACH

In order to present the concept of employee agility as a response to the new challenges of economy 4.0, a model was constructed that is a kind of imperative in the process of adapting human capital to turbulent changes in the environment. This model is shown in Figure 2.

The presented model shows a comparison of the features of an agile enterprise, educated as a result of new challenges emerging in the market environment of economy 4.0. The market environment forces the need to implement new processes related to rapid digitization and digitization. Agile employees in response to such a challenge must develop the ability to cope with change.

The challenge of the modern environment is also innovation and flexibility of action. In response, an agile enterprise develops operational capacity, understood as the ability of the company's business processes to effectively use market innovations. Rapid response to market incentives, competence and flexibility can only be achieved through the use of innovative practices and tools, which are necessary resources for agile organizations. In the process of shaping and creating innovative processes, the market has an informative, inspiring and verifying function at the same time. Innovative processes are shaped under the influence of information coming from the market.

Contemporary reality has been dominated by the use of ICT technologies. In response, employees should learn to take advantage of the opportunities offered by ICT intelligently and quickly. Another determinant of economy 4.0 is the rapid development of e-commerce. Therefore, employees endowed with agile attributes must demonstrate the ability to prepare an offer that allows them to meet the changing requirements of individual customers.

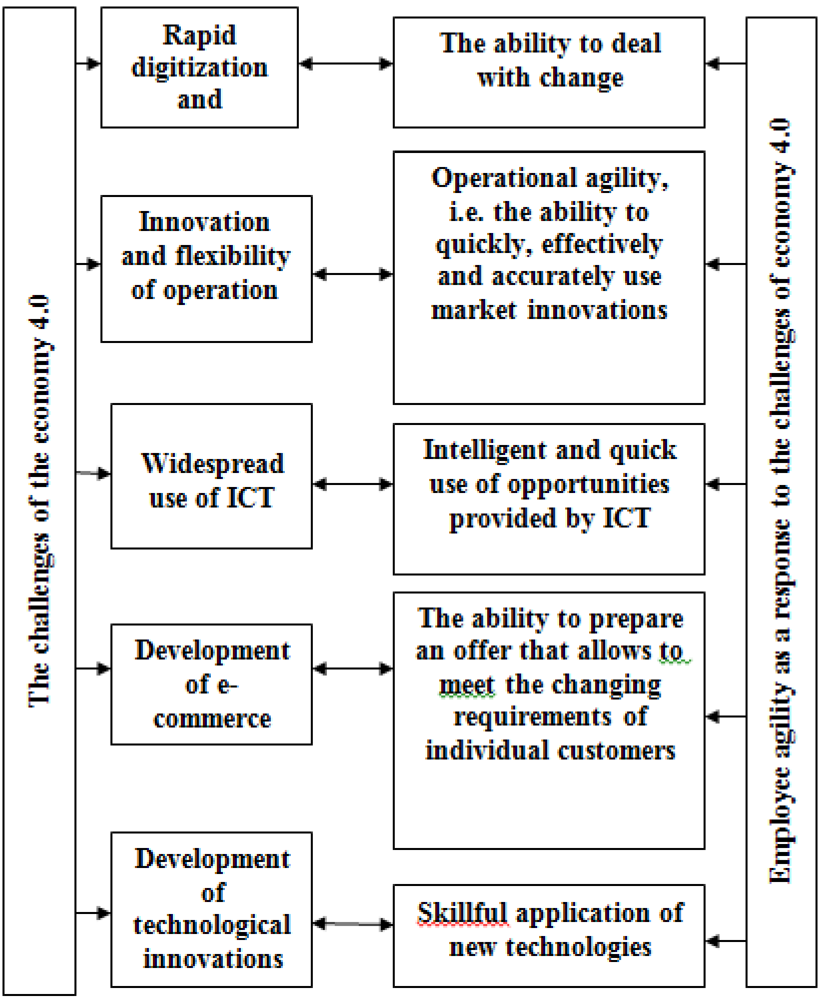

Figure 2. The essence of employee agility
Source: Own study

A feature of the modern environment is the emergence of new market opportunities. Agile employees in response to such a challenge must become smart, that is, acquire the ability to quickly capture opportunities and threats that flow from the market. The ability to take advantage of opportunities becomes possible thanks to such attributes as: quick-wittedness, intelligence and flexibility. The staff of an agile company consists of talented employees who can create their own opportunities. It is also worth mentioning that the market environment also requires agile employees to skillfully use new technologies.

The challenges associated with the functioning of the economy 4.0 provide the company with more and more new challenges. In order to meet them, the staff employed in it must develop new, agile features that would allow them to survive in a turbulent environment. The model of employee agility presented in this chapter as a response to the new challenges of Economy 4.0 precisely defines the features of employee agility, which become a response to contemporary market challenges that are the determinant of the functioning of Economy 4.0. Briefly, we can mention here the ability to cope with changes, operational ability, i.e. the ability to quickly, effectively and accurately use market innovations, the use of opportunities offered by ICT technologies, the ability to prepare an offer to meet the changing requirements of individual customers, acumen, i.e. the ability to quickly capture market opportunities and diagnose threats, and skilful use of new technologies.

Finally, it should be stated that the success of the company in skilful adaptation to the new reality that economy 4.0 has become and the effective use of opportunities from the environment is not only a matter of employees having agile features, but certainly determines to a large extent about effective management in a turbulent and unpredictable environment.

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ROLE OF THE TOURISM 4.0 IN VISEGRAD COUNTRIES

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Abstract

The industrialization of production and the advancement of technology began in the eighteenth century and continue today. The First Industrial Revolution resulted in a complete shift in production and the transition from manufacturing to machine, i.e. industrial production. The Fourth Industrial Revolution was characterized by the digital transformation of the new modern age. This change is known as Industry 4.0. The digital transformation led to changes in the tourism industry, so its companies, in addition to their traditional ones, are gaining new roles and new business models in which the flow of information is significantly faster. For that reason, the competitiveness of tourism industry companies has become a global phenomenon. This paper will analyze the digitization process in the Visegrad Group countries. There will also be a comparative analysis among the members of the Visegrad Group, but also the achieved level of digitalization compared to the European Union. The obtained results will show the imbalance in the achieved levels of digitalization in the tourism industry and the different readiness of tourism policy carriers to implement modern technologies in their businesses, regardless of the awareness of the necessity for digitalization. Without it, business,

not only in the tourism industry but also in others, will be almost impossible in the future.

Keywords: *Industrial Revolutions, Industry 4.0, Tourism 4.0, Digitalization*

1. INTRODUCTION

Information and communication technologies have taken precedence in every industry in recent years. Advances in technology evolved rapidly, from the first industrial revolution to internal combustion engines. The development of information technologies influenced changes in all branches of industry. While the first three revolutions were synonymous with mechanization and electricity use, the Fourth Industrial Revolution also occurred. It is the digital transformation of the new modern age in which both production and products (services) are changing. This change is known as Industry 4.0 or the Fourth Industrial Revolution. According to the European Parliament, Industry 4.0 describes the organization of production processes based on technology and devices that communicate autonomously with each other along the value chain in virtual computer models (European Parliament, 2021). Digital transformation is characterized by huge databases.

The Industry 4.0 concept was first mentioned in 2011 in Hanover, Germany. At that time, the concept was a proposal for developing a new industrial policy based on the strategy of the most modern technology. Industry 4.0 includes Internet tools and services with constant communication over the Internet that enables interaction and information exchange. The exchange of information occurs in three ways, not only between people but also between people and machines and between machines (Dominici et al., 2016).

The importance of tourism for the economic growth of a country was discussed and confirmed several times. Tourism, with its performance, has multiple implications for one economy. Tourism is also recognized as a multidimensional industry and as a rapidly expanding activity that influences other industries to grow (Durkalić et al., 2019). Progress and business success depend on the readiness of tourism policy carriers and tourism companies to implement modern technologies in their business (Pantić & Milojević, 2019).

2. LITERATURE REVIEW

Korže (2019) conducted a study that investigated the manner and degree of acceptance of Industry 4.0 by tourism. According to him, it is still a concept that should come to life because it is in the initial phase. The results he obtained indicate a lack of understanding and different use of the term Tourism 4.0 by state governments and tourism policymakers. The achievements of the Fourth Industrial Revolution, which are very suitable for designing tourist services, have been in use for some time.

Stankov & Gretzel (2020) talk about the link in the causal relationships of Industry 4.0 and Tourism 4.0, which has brought along a great connection of tourism systems as a consequence. However, they critically considered this phenomenon, having in mind the tradition of both users of tourist services and carriers and creators of the tourist offer, which is extremely characteristic in countries that did not achieve a satisfactory level of economic development.

Bertacchini et al. (2021) conducted research on the importance of Technology 4.0 for the tourism sector. The subjects were students, and the answers were obtained through social networks. The encouraging fact is that students are aware of the importance of implementing advanced technologies, which can be a significant comparative advantage, in the tourism sector as quickly as possible. This entails the necessity of learning and readiness for what the subjects were aware of and the concept they supported.

Ozturk (2021) spoke about the fact that technological development in recent years is affecting the lives of people and societies faster than in the past. Development in communications, robotics, transport, etc., is called the 4th Industrial Revolution or Industry 4.0 in the industrial sector. Technological development created significant changes in the service and industrial sectors. Industry 4.0 also led to changes in the transformation of the tourism sector and is likely to happen in future processes.

3. INDUSTRY 4.0 AND TOURISM IN THE EU

The digital transformation brought changes in the tourism industry as well. With the exponential development of digital technologies, there has been a revolution in tourism companies, products, ecosystems, and destinations. The Fourth Industrial Revolution transformed the traditional role of tourism producers and consumers into new roles, new business models and competencies. The development of digital platforms increased the scope and types of tourism products, services, and experiences, increasing feedback speed. These changes led to new opportunities and challenges for small and medium enterprises (SMEs) in tourism to meet consumer demands and reach new markets. In addition, the benefits that digital transformation brought to tourism can be seen in competitiveness. Coordinated efforts to adopt a digital culture in SME tourism ensure the global competitiveness of many European destinations (Dredge et al., 2019).

In the context of tourism and the new industrial revolution, the following research questions are formed:

Research question 1: *What technologies are currently associated with the Industry 4.0 concept in the tourism industry?*

Research question 2: *What is the current state of technological progress in the tourism industry?*

Research question 3: *Which countries have already acquired the Tourism 4.0 industry?*

Research question 4: *What are the long-term implications of digitalization in tourism for future research?*

Based on the defined questions, the primary goal of this paper is to fill a gap in the literature by providing a comprehensive overview of the currently researched and acquired Industry 4.0 related to the tourism industry.

The European industry is strong in digital sectors such as car electronics, security and energy markets, telecommunications equipment, business software and laser and sensor technologies. Europe is also the host of world-class research and technology institutes (Pantić & Živković, 2020; Milojević et al., 2020). However, high-tech sectors face serious competition from other parts of the world. Europe is powerful in many traditional and especially engineering sectors with huge potential for digitalization, especially for small and medium-sized enterprises (SMEs) and medium-sized companies, even strengthening Europe's position. However, there are large disparities in digitization between regions (Obradović et al., 2013).

Rapid growth and positive economic impacts of the tourism industry are the reasons why many countries decided to plan and develop tourism. Tourism is one of the leading economic activities in the EU, which significantly contributes to economic development (Lakićević & Durkalić, 2018). The basic condition for tourism growth is to increase the free time and income of households of people who want to travel. In addition, technological innovations made travel planning easier. The tenth year of consecutive growth was 2019, in which 1.5 billion international tourist arrivals were recorded (UNWTO, 2020). This growth was interrupted by one of the biggest health crises, the new coronavirus pandemic, which in 2020 alone caused a drop of 74% in international tourist arrivals and a loss of $ 1.3 trillion in export revenues (UNWTO, 2021).

An interesting group of countries regarding tourist trends is the famous European Quartet or Visegrad Group (V4). The countries of the Visegrad Group are characterized by EU membership, but also unique civilizational and cultural values of common roots. The countries of the Visegrad Group are the Czech Republic, Hungary, Poland and Slovakia. With this in mind, Figure 1 shows the number of overnight stays in tourist facilities in the mentioned group of countries.

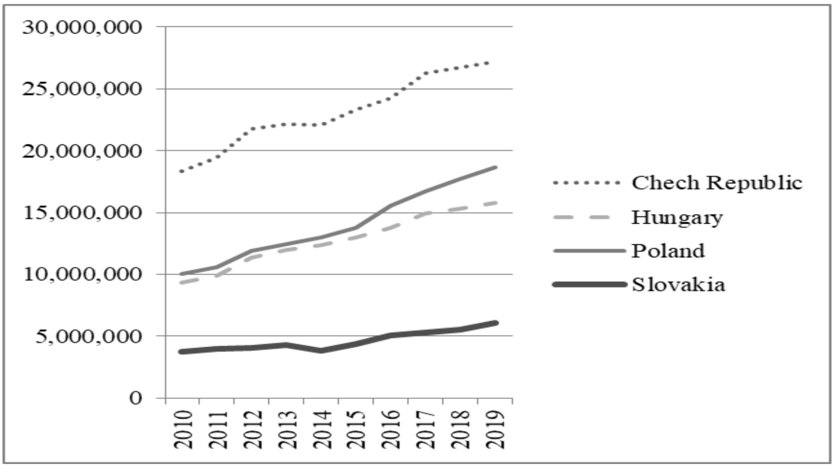

Figure 1. Number of overnight stays in tourist facilities in the Visegrad Group countries
Source: (Eurostat, 2021)

The illustration in Figure 1 clearly shows that all countries and the entire EU achieved an increase in the number of tourist overnight stays in the period from 2010 to 2019. The country that stands out significantly from the mentioned group is the Czech Republic, where the number of overnight stays in 2019 increased by almost 70% compared to 2010. Similar tendencies are observed in Hungary and Poland. At the same time, Slovakia recorded a slightly weaker decline in the number of overnight stays in 2014, so the number of overnight stays in 2019 increased by 62% compared to 2010.
Table 1 shows the share of the V4 group in the total number of overnight stays in the European Union in the period from 2010 to 2019. Like absolute expressions, the relative share shows that the Czech Republic is the leader regarding the number of overnight stays, followed by Poland and Hungary and Slovakia. The share of tourist overnight stays in V4 countries shows that this group accounts for about 5% of tourist overnight stays of all overnight stays in the European Union.

Table 1. Share of overnight stays in V4 countries in the number of overnight stays in the EU27

Year/Country	Czech Republic	Hungary	Poland	Slovakia
2010.	1.99%	1.02%	1.09%	0.41%
2011.	1.96%	1.00%	1.07%	0.40%
2012.	2.12%	1.11%	1.16%	0.39%
2013.	2.06%	1.12%	1.16%	0.40%
2014.	2.00%	1.12%	1.17%	0.35%
2015.	2.02%	1.12%	1.19%	0.38%
2016.	2.00%	1.14%	1.28%	0.42%
2017.	2.03%	1.16%	1.29%	0.41%
2018.	1.99%	1.14%	1.32%	0.41%
2019.	2.00%	1.16%	1.37%	0.44%

Source: UNWTO (2021)

The European Union went a step further in digitalization and created the Digital Economy and Society Index – DESI. The Digital Economy and Society Index is an important starting point for identifying problem areas that an EU Member State needs to address in order to improve its digital performances. For example, according to the report from 2021, a quarter of companies use at least two artificial intelligence technologies. The adoption of two or more artificial intelligence technologies is most present in the Czech Republic (40%), followed by Austria (37%), Greece and Lithuania (both 34%). The implementation of artificial intelligence is the least present in Ireland (14%), Slovakia and Estonia (both 15%) (European Commission, 2021).

4. PROGRESS OF SELECTED COUNTRIES IN THE INDUSTRY TOURISM 4.0

The research on Tourism 4.0 is still in the initial phase. With this in mind, an investigational type of research was chosen to achieve the goals and analyze the results of the Visegrad Group countries. A descriptive method of presenting results was used for the analysis and presentation of results.

Data collection was performed by researching Internet content. The research process included the following steps: identification of the research field, analysis documents, assessment of data availability and extraction and analysis of data. There are two types of data extraction: current state and evolution.

According to the latest update, on November 1, 2021, there were 970,677 digital databases in all industries in the European Union. In the table above, it is possible to see how these data are distributed by industries. Namely, agriculture and the environment have the largest share of databases in the total number of digital data. This is followed by the judiciary, the legal system and public security.

Table 2. Number of databases by areas in Visegrad countries

Country	Share in the overall database	Total number of digital data
Czech Republic	31.5%	346051
Hungary	0.01%	57
Slovakia	0.25%	2645
Poland	1.25%	14123

Source: Data Europa EU (2021)

The total number of digital data in European Union databases is 1,099,503. The leading country in terms of digitalized data is Germany, with a 32.5% share in the total base of the entire EU. Immediately after Germany is the Czech Republic with 346,051 databases, accounting for 31.5% of databases of the whole EU. So, considering all the countries of the Visegrad Group, the Czech Republic is among the leading countries in terms of data digitalization, both in the EU and in V4. Poland accounts for 1.25% of databases of the entire EU, while Slovakia participates with 0.25% and Hungary with only 0.01% of digitalized data in the whole EU.

However, suppose the entire Visegrad Group is taken into account. In that case, it is important to point out that these countries occupy 33.01% of the databases of the whole EU, while other countries participate with 66.99%. An illustration of these data is shown in Figure 2.

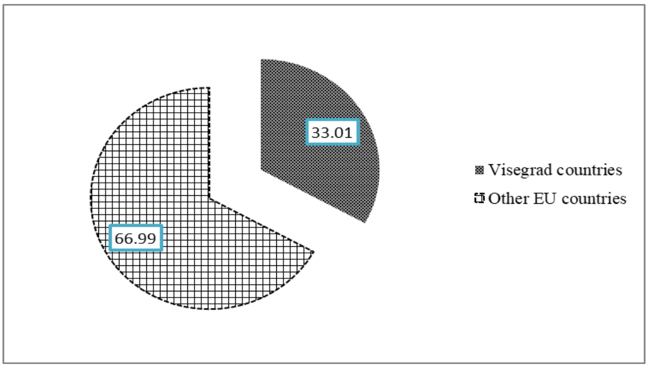

Figure 2. Share of Visegrad countries and other EU countries in database storage
Source: European Commission (2021)

The term Tourism 4.0 dates back to 2017, when it appeared in documents of less than ten countries. The term was used as a base for fostering tourism within a country while enabling technological changes in tourism and the implementation of a new digital tourism product (Korže, 2019). The key features that characterize Tourism 4.0 are technological changes in tourism – digitalization, big data, robotization, artificial intelligence, mobile technologies, virtual reality, distribution book technologies, etc.
In 2017, the first European country to introduce Tourism 4.0 was Portugal. Such an initiative encouraged promotion for the use of key technological advances in tourism, entrepreneurship, and innovation in tourism. Later, this term was used in wine tourism projects.

The COVID-19 pandemic affected all branches of the industry but especially stopped the business in tourism. In order to survive in the market, stakeholders sought Industry 4.0 options to include automation and data exchange in new technologies (cyber systems, Internet tools) in their business.

Today, Slovenia is the leading country when it comes to Tourism 4.0. By using innovations and technologies from Industry 4.0, Slovenia aims to change the perception of tourism and the business sector around it. Tourism 4.0 refers to the transition from a tourist-centred perspective to a tourism-oriented perspective. This is done by involving local people, local authorities, tourists, service providers and governments to create a tourism experience that is both physical and digital. A new perception of tourism can be explored through research and technology validation projects (European Commission, 2021).

According to the World Economic Forum research, which publishes the Tourism Competitiveness Report every other year, the readiness for information and communication technologies is also included. According to ICT readiness, in 2019, out of 140 observed countries, the Czech Republic is on the 32nd and Slovakia in 33rd place. Poland is 40th on the list, while Hungary is 47th.

Efforts of other countries to acquire Industry 4.0 are poor, but there is progress. Through its Ministry of National Economy, Hungary published strategic documents on the directions of innovative development of the industrial sector. The program analyses Industry 4.0 initiatives by several European countries, including Germany, Austria, Romania, Slovakia and others. When it comes to readiness for Industry 4.0, according to a study published by Roland Berger, the analysis shows that although Hungary is among the most industrialized countries in Europe (according to the share of the manufacturing sector in GDP), the sophistication of the production process, degree of automation, workforce readiness and the intensity of innovation in the country are still below the European average (Berger, 2014).

According to research by Vrchota & Pech, over 51% of small and medium enterprises use high technology (Vrchota & Pech, 2019).

Regarding the Tourism 4.0 industry, the Czech Republic launched the DIH T4.0 platform (Digital Innovation Hubs) in Brno to provide new services and products using digital technologies to tourism industry stakeholders. The concept of digital innovation is part of the development of the Single Digital Europe policy. DIH is part of the supporting infrastructure for promoting tourism policy goals. DIH works by bringing the issue of digitalization of transmission at the national and regional level directly to the institutional environment and, above all, to the corporate environment, with special emphasis on the development of the digital competence of SMEs. Some of the projects that have been implemented are: Capitalize on a Crisis, Digital academy, Novéhory.cz – a testing platform for the distribution of digital content, The role of innovative regional clusters in tourism development.

Based on research on new technology tourism 4.0 in museums in Poland, the author Naramski concluded that only 0.9% of museums in the entire territory of Poland implemented some idea of smart tourism. What is significant is that almost 18% of museums plan to implement this policy in the future. Based on the research results, it can be concluded that smart tourism is an unknown concept to museums in Poland. Traditional tourist tours in Polish museums are the most common form of sightseeing, but many museums introduced technical solutions that support their work. Some museums plan to develop the T4.0 industry, especially by increasing audio-guided tours and designing their mobile applications.

Slovakia is a country where the use of Internet services and digital technology implementation is at the EU average level (Gajdošík, 2018). For this reason, it can present an accurate picture of the development perspective and development problems in the implementation of Tourism 4.0.

The authors Grenčíková and associates point out that with the acquisition of Industry 4.0 in Slovakia, employment will vary depending on the size of the company (Grenčíková et al., 2021). While SMEs will retain their employees, medium-sized companies and

especially large companies will lay off workers. However, as the Slovak Government points out (Slovak Government, 2005), in order for tourism to grow and develop in Slovakia, equal regional support for tourism at all levels (states, regions, cities, municipalities and companies) is needed. Regarding Slovakia and digital performance, it should be noted that Slovakia is ranked 20th out of 27 member states according to the Digital Economy and Society Index (DESI) published by the European Commission (European Commission, 2018). Slovakia belongs to the group of low-performing countries – in addition to Slovakia, this group also includes Bulgaria, Cyprus, Greece, Croatia, Hungary, Poland, Romania and Italy.
The presented examples of practical and theoretical implementation of technology in different industry sectors show that tourism has followed the steps of the 4.0 Industry. However, due to the multidisciplinary of the tourism industry and the nature of its products and services, it differs depending on the country, compared to Industry 4.0.

5. CONCLUSION

The development of human civilization is characterized by significant changes in living conditions and in the conditions in which a wide range of products are produced. In an attempt to single out one moment in the progress of civilization that radically changed the method of production and economic functioning, it would certainly be the First Industrial Revolution, which marked the transition from manufacturing to industrial capitalism. All subsequent industrial revolutions continued the trend of change and replaced living with materialized labour. The Fourth Industrial Revolution or the "transformation of the new modern age" is a period of a new significant change in which the production of services, in particular, is changing. It also brought changes in the tourism industry. We are witnessing the accelerated development of digital technologies that contributed to the transformation of the way of doing business of tourist companies and tourist products that are on their offer. Thus, these companies enter the modern business system, neglecting the current traditional one. Research on Tourism 4.0 is still in its initial phase in the Visegrad Group countries, but the Czech Republic stands out. In terms of digitalized databases, it also leads among EU countries with a share of 31.5%. However, all the Visegrad Group countries account for 33.01%, which indicates a big difference between the Czech Republic and other members of this group. It is clear that in the time to come, it will be necessary to digitalize other members of the Visegrad Group because any technological lagging behind can have far-reaching consequences for any activity, including the tourism economy.

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ACCEPTANCE AND PERCEPTIONS OF DIGITALISATION IN SMEs DEPENDING ON ORGANISATIONAL ROLE OF EMPLOYEE

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Abstract

This study aimed to analyse the employees' perception of working in the digitalised business environment. Respondents answered questions about the practical application of digital technologies (Behavioral intention and User behaviour) and their self-efficacy in this regard (Self-efficacy in digitalisation). The authors also examined their attitudes towards the digitisation process, fears (Anxiety regarding digitised working environment), and expectations (Performance and Effort expectancy). In this way, the most difficult and the most manageable challenges for employees in performing work tasks in digitalised SME's, have been singled out. Another aim was to define how the readiness for digital innovations is distributed among managers and employees and whether their perceptions differ significantly. Descriptive statistics showed a satisfactory level of readiness and acceptance of digital technologies by employees from each organisational level. The correlation analysis results indicated a positive correlation between the organisational role of respondents and groups of questions related to Behavioural intention, Attitude towards digitalisation, Performance and effort expectancy. On the other hand, the answers to the questions from the groups Use behaviour, Self-efficacy and Anxiety do not correlate to the respondent's position in the company. The discriminant analysis was performed in order to recognise the statement that best reflects the distinction in the

perception of different aspects of digitalisation depending on the organisational role of the respondents. Statement *Digitalisation impacts the profits and performances of the company* was extracted. It indicates that the perception of the impact of digitalisation on the company's overall business differs significantly between owners, top managers, managers, and operatives in the SMEs.
Keywords: *Digitalisation, SMEs, Perceptions, Managers, Non-managers*

1. INTRODUCTION

Industry 4.0 is a novel concept that boosts productivity. The arrival of the fourth industrial revolution has resulted in a significant improvement in the efficacy of product and production development. Industry 4.0 is transforming the manufacturing industry and the economics of value creation. One of the main challenges of the concept of Industry 4.0 is the integration of small and medium-sized enterprises (SMEs), as they play an essential role in industrial value chains that will be digitised from suppliers to end customers. However, the implementation stages for Industry 4.0 in SMEs and the resources required to reach the next level are poorly understood. SMEs represent an important part of the economy. Given its significance, very few studies are currently being conducted to address SME-specific barriers (Mittal et al., 2018; Masood & Sonntag, 2020).
SMEs appear to be having difficulty integrating the fourth industrial revolution (Schumacher et al., 2016; Ganzarain & Errasti, 2016). The process of managing SMEs is very specific because the business activities are carried out under conditions of scarce resources (Milosevic et al., 2014). Many SMEs are still in the early stages of digitalisation (Pech & Vrochta, 2020). Small and medium-sized enterprises face more tremendous digitalisation obstacles than large organisations (Matt & Rauch, 2013; Brunswicker & Vanhaverbeke, 2015; Bi et al., 2015; Grube Hansen et al., 2017; Horváth & Szabó, 2019; Türkeş et al., 2019; Orzes et al., 2019). SMEs

face primarily two constraints compared to larger firms: operational resources and financial budget.

The level of digitalisation of a company can be defined as incorporating digitalisation into the core business. Indicators of digitalisation include characteristics of an organisation related to the design of information systems, particularly the adoption of digital (IT and ICT) or disruptive technologies (blockchain). Because many SMEs lack highly qualified employees familiar with all aspects of digitalisation, practitioners and academics have developed fewer maturity models (Kääriäinen et al., 2020).

The success of the digitisation process in SMEs is not determined solely by technological factors. Employees in the company are a key factor in a successful business, thus implementing innovative and modern techniques and tools. Therefore, it is essential to dedicate to human resources, not only in terms of conducting training to improve knowledge and skills in the application of digital technologies but also in motivating employees to accept innovations and apply them. Nevertheless, there is no significant number of studies in the literature to date that have studied the psychological and social aspects of the introduction of digitalisation.

Shared beliefs about digital readiness among management and employees are necessary for successfully guiding and implementing organisational change. The company manager should encourage employees to innovate work processes to improve the company's performance (Virglerova et al., 2021). Managers should raise awareness of digitalisation and shape positive employee attitudes toward it. However, there are not many overlaps between managers and employees regarding readiness for digital innovations. Managers and employees (non-managers) appear to have different readiness levels, with managers more positively perceiving enthusiasm for digital innovations than non-managerial employees.

Some studies find that managerial positions are more likely than non-managerial employees to perceive organisational readiness for digital innovation positively, both within and across sectors (Mellesse, 2021).

The preliminary findings show that people's perceptions of innovations vary greatly.

2. THEORETICAL FRAMEWORK

2.1. The concept of Industry 4.0

Throughout history, industrial revolutions have shaped the society we live in and how we make things. The concept of a fourth industrial revolution is referred to as Industry 4.0. It originated in the German government's strategy to strengthen the competitiveness of its manufacturing industry, and it first appeared in 2011 at the Hanover Fair (Kagermann et al., 2013; Lasi et al., 2014). Industry 4.0 is described as being all about novel business models and new ways of creating value (Kagermann et al., 2013), as well as the implementation of technologies from the shop floor to top management (Dorst & Scheibe, 2015), and from the supplier to the customer (Fatorachian & Kazemi, 2020). This concept considers how a company can generate more value from the available data collected by the critical underlying technologies. This shift toward full digitalisation of processes (Lee et al., 2015; Hofmann & Rüsch, 2017) and organisations is viewed as the new promising fourth industrial revolution (Kamble et al., 2018) which has enormous potential for improving sustainability, reducing pollution, improving product efficiency, increasing production stability, lowering operating costs, and providing various other benefits to the plant (Javaid et al., 2022).
Industry 4.0 is currently one of the most hotly debated topics in the manufacturing world. Industry 4.0 represents a new manufacturing paradigm (Dorst & Scheibe, 2015). It refers to a set of new technologies that can revolutionise manufacturing. Industry 4.0 technologies seek to improve manufacturing processes by utilising computer technology, which aids in automation and productivity. Robotics, artificial intelligence, machine vision, big data, cloud

computing, and machinery education are examples of advanced technologies.

Industry 4.0 can be understood not only in terms of the implementation of different technologies but also in terms of what organisations can do with those technologies. Many studies were conducted on finding new technologies of integrated products and production platforms to aid decision making in engineering processes. Numerous studies imply a constant need to investigate new ways of integrating product and production platforms. Saravanan et al. (2021) investigate whether production companies can be organised based on Industry 4.0 adoption trends and how these patterns define specific industrial 4.0 technology configurations. They aid in understanding what is required for the proper adoption of such technologies in manufacturing and production companies. Elhusseiny and Crispim (2022) tried to identify the barriers and opportunities of adopting Industry 4.0 in the manufacturing sector in developed vs developing countries. According to the findings of this study, developing countries face more barriers and perceive more opportunities about Industry 4.0. Organisational and technical obstacles were the most common in both sets of countries. Dogea and Stolt (2021) attempt to determine the current state of practice in today's industry regarding their degree of automation in Swedish companies. According to the findings, the companies have dealt with three application fields: simulation and calculation, automation, and data management. There are some commonalities, such as a lack of software tools, design and production automation, data migration and collection, or data handling in production. The study's findings strongly suggest that enterprises use Industry 4.0 techniques to improve their product and production assets. James et al. (2022) use a hybrid methodology to identify and analyse the Human Resource Management (HRM) challenges associated with the implementation of Industry 4.0 in the Indian automobile industry. The findings can help automakers mitigate the causes of HRM challenges and promote the implementation of Industry 4.0 in their companies in the most productive way possible. Satyro et al. (2022) broaden the methodology that dominates the academic literature on Industry 4.0 by finding relevant challenges and benefits for its implementation, assessing the relevance of sustainability in Industry 4.0, and assessing its potential impact on society in a developing country. Industry 4.0 experts from multinationals and national companies in Brazil's industrial sector were consulted. The results revealed that the most anticipated benefits were an increase in the companies' global competitiveness and an improvement in the quality of their production lines. At the same time, the most recognised challenges were the struggle in changing the organisational culture, the high investments, and the problems in hiring/training people in digital technology.

Adoption of new technology is a significant driver of company performance and economic development. However, transferring and adopting new technologies is not smooth, especially as more advanced capabilities are required for new technology to operate effectively. Delera et al. (2022) create a framework for analysing the drivers of advanced digital production technologies associated with Industry 4.0 adoption in developing economies. They inquired whether firms' participation in global value chains (GVCs) can facilitate the adoption of Industry 4.0 technologies in Ghana, Vietnam, and Thailand's manufacturing sectors. The findings revealed that firms' participation in GVCs is associated with the adoption of Industry 4.0 technologies and is associated with firm-level performance.

Integrating cyber-physical systems (CPS) based on the Internet of Things (IoT) concept into manufacturing is the leading technological foundation of Industry 4.0. Its goal is to create intelligent, automated, and interconnected industrial value. CPS enable data collection by-products, manufacturing facilities, and customers across the entire value chain (Kagermann et al., 2013; Lasi et al., 2014). These CPS and IoT properties enable the key features of Industry 4.0 – horizontal and vertical integration (Kagermann et al., 2013; Lasi et al., 2014; Ghobakhloo, 2018; Müller et al., 2018).

Aside from these operational benefits, strategic potentials such as entirely digitised, connected, intelligent, and decentralised value chains

that contribute to ecological and social goals are also expected. Furthermore, it paves the way for developing new services and business models (Frank et al., 2019; Kagermann et al., 2013; Müller et al., 2018, 2021).
In today's competitive business environment, Industry 4.0 technologies, sustainability, and coordination are becoming increasingly important. Over the last few years, there has been a lot of positive buzz about the implications of Industry 4.0 technologies for sustainable development. Expectations for the opportunities offered by Industry 4.0 for sustainable manufacturing are high. Still, a lack of accurate understanding of how Industry 4.0 technologies enable sustainable manufacturing is a major obstacle for businesses undergoing digitalisation and sustainable thinking. Ching et al. (2022) clarify this knowledge gap by creating a roadmap that explains how Industry 4.0 and the underlying digital technologies can be used to support and facilitate sustainable manufacturing's triple bottom line. They identified the sustainability functions that contribute to sustainable manufacturing due to Industry 4.0. The relationships that may exist within the sustainability functions are also identified. The findings explain how various Industry 4.0 sustainability functions contribute to developing sustainability's economic, environmental, and social dimensions. The resulting implications are expected to serve as a strategic guide for manufacturers, industrialists, and academia in leveraging Industry 4.0 digital transformation to support sustainable development.
Toktaş-Palut (2022) investigates the effects of Industry 4.0 technologies and coordination on supply chain sustainability. Whether or not the supply chain invests in Industry 4.0 technologies, as well as the level of investment, have an impact on its economic, environmental, and social sustainability. The findings show that, while a more coordinated classic supply chain can outperform a decentralised Industry 4.0 chain in terms of market demand and profitability, coordination alone is insufficient for the traditional supply chain to be considered sustainable. Furthermore, even if a decentralised Industry

4.0 supply chain makes efforts in all three sustainability dimensions, its overall sustainability is not guaranteed based on the decision maker's thresholds. On the other hand, the supply chain takes advantage of the benefits of Industry 4.0 technologies in conjunction with coordination, leading the market in terms of overall sustainability. This result demonstrates the importance of Industry 4.0 technologies and coordination in ensuring the long-term viability of a supply chain. Furthermore, as consumers become more conscious of the significance of purchasing sustainable products, supply chains are encouraged to invest more in sustainability initiatives and Industry 4.0 technologies, resulting in a more sustainable world.

Srivastava et al. (2022) investigate the key factors influencing the decision to implement Industry 4.0 in India's technical education institutes (TEIs). Because they are in charge of the workforce of the digital future, TEIs play a critical role in achieving this goal. According to the findings, the organisational dimension is crucial in determining whether or not to implement Industry 4.0. According to this research, top management support, internal resources, and the capabilities of the teaching staff are critical for the adoption of Industry 4.0. Furthermore, there are significant differences in the adoption of Industry 4.0 between public and private TEIs.

Satyro et al. (2022) draw attention to the problem of unemployment caused by the implementation of Industry 4.0 and the potential social impacts on local society. This study encouraged researchers and civil society to contribute theory and practice to the social dimension of sustainability in Industry 4.0 to prevent the worsening of social inequalities.

2.2. Digitalisation in SME's

One of the major trends influencing business and society is digitalisation. Social, mobile, cloud, analytics, Internet of things, cognitive computing, and biometrics are examples of „powerful, accessible, and potentially game-changing technologies” (Ross, 2017).

In its' most basic form, digital transformation is the use of new digital technologies in everyday organisational life (Warner and Wäger, 2019). It is a commonplace technology that serves as the foundation for all modern innovative economic systems. Because the digital transformation affects businesses as a whole, changes and adjustments will be visible at various levels of the organisation (Hausberg et al., 2019).

Digitalisation is more than just technology. The term „digitalisation" describes a wide range of socio-technical phenomena and processes associated with adopting and applying these technologies in more prominent individual, organisational, and societal contexts. Cloud computing, the Internet of things, artificial intelligence, additive manufacturing, and robotics are examples of digital technologies classified within an organisational context (Bloching et al., 2015). The digitalisation of production processes can increase efficiency, improve product quality, and provide numerous other benefits (Doh & Kim, 2014; Kusiak, 2018). The most commonly used terms in literature and practice for these digitalisation initiatives are „future of manufacturing", „smart manufacturing", and, in general, and primarily, „Industry 4.0" (Yin et al., 2018; Liao et al., 2017). Schönfuß et al. (2021) use the term digital manufacturing „as the use of digital information from a variety of sources to improve production processes, products, and services. Faced with a digital revolution, national and regional governments are increasingly defining digitalisation as a strategic priority and launching large-scale initiatives to promote the digital transformation of science, industry, and society (Legner et al., 2017).

There are numerous definitions of SMEs (Gelinas & Bigras, 2004; Holátová & Březinovă, 2015; Pullen et al., 2008; EC, 2015). SME's account for nearly 99 per cent of all businesses in the EU. SME's are regarded as a key driver of the European Union's (EU) economy. Because of their significant presence in the industry and their roles as suppliers to large corporations, the SME sector can initiate industry-wide changes for long-term, digital development. Industry 4.0 adoption opens up new opportunities for SMEs, allowing them to innovate and stay competitive in global markets (Mittal et al., 2018). Given their role in industrial value creation, SMEs must be integrated into the concept of Industry 4.0 (Müller et al., 2018; Moeuf et al., 2018, 2020).

While Industry 4.0 and similar technologies have numerous potential manufacturing benefits, the vast majority of these innovations are developed for and by large corporations. However, there is a lack of understanding about how these technologies are currently implemented in businesses. Most studies have concentrated on Industry 4.0 adoption in multinational and large enterprises and listed several issues without relating them to developed or developing countries (Buer et al., 2020). Only a few studies have looked into SMEs' Industry 4.0 adoption in the manufacturing sector, demonstrated the potential benefits of Industry 4.0 to SMEs, concentrated on the specific barriers faced by SMEs in developing countries (Kumar et al., 2021), and classified the main barriers into dimensions (Buer et al., 2020; Kumar et al., 2021; Yüksel, 2020; Al-Shboul, 2019; Ghadge et al., 2020).

Given that Industry 4.0 is a technology consortium (Boyes et al., 2018), it is not surprising that larger engineering companies are closer to completion implementing Industry 4.0 than SMEs. Many SMEs are unprepared for the structural changes that this revolution will entail – they lack the necessary specialist staff or have a cautious or sceptical attitude, primarily motivated by financial concerns, toward a technology strategy that they are still unfamiliar with (Kagermann et al., 2013). Companies that produce repetitive goods have an easier transition to Industry 4.0 than companies that produce non-repetitive goods (Strandhagen et al., 2017).

When it comes to implementing Industry 4.0, several barriers of various origins are significant for SMEs (Müller et al., 2021; Raj et al., 2019). Numerous literature sources already describe difficulties and mistakes that organisations face when implementing this concept (Kagermann et al., 2013; Agca et al., 2017; Roblek et al., 2016; Schumacher et al., 2016; Ganzarain & Errasti, 2016; Schuh et al., 2017; Griessbauer et al., 2016; Darnley et al., 2018). Difficulties are challenges and obstacles that companies must overcome to implement Industy4.0 action plans (Agca et al., 2017). Mistakes can be interpreted as errors committed by companies when implementing such initiatives (Colotla et al., 2018).

Masood and Sonntag (2020) identified three themes: financial resource limitation, knowledge resource limitation, and technology awareness limitation. In terms of the financial resources, obvious mitigation options include lowering the overall cost of digital adoption (Doyle & Cosgrove, 2019; Lins & Oliveira, 2020; Niemeyer et al., 2020; Amaral & Peças, 2021). Raising the level of managerial skills in the company or lowering the skills needed to implement and operate digitalisation solutions are potential solutions to address the knowledge resource limitation.

Amaral and Peças (2021) attempted to understand the impact of SMEs' inherent limitations on their integration into Industry 4.0. They conducted a three-month full immersion investigation in a traditional manufacturing SME to assess such constraints. They present two digitalisation propositions that show paths to increasing an enterprise's level of digitalisation. Following the methodology of this research will enable enterprises to be more aware of their current state of Industry 4.0 maturity and create their way into the fourth industrial revolution.

Industry 4.0 implementation consists of a series of activities/phases, but it has a high level of complexity because digitalisation requires several different project management competencies (Hirman et al., 2019; Ribeiro et al., 2020). It is necessary to understand the potential barriers and opportunities of Industry 4.0 adoption to define the profile of the project manager who will realise the implementation and conduct a risk analysis of the implementation project. Estensoro et al. (2021) propose a framework for Industry 4.0 implementation in SMEs based on the stage of development initially developed between researchers, policymakers, and manufacturing SMEs in Spain.

The digitalisation of the manufacturing sector is critical for future productivity increases. Programs like Industry 4.0 have gotten a lot of attention. Numerous authors found a gap in digitalisation research in manufacturing SMEs. Many studies are aimed against larger corporations, ignoring SME-specific digitalisation challenges. The primary cause of the disconnect is the discussion of digitalisation from a technology-centric perspective. Schönfuß et al. (2021) propose a problem-centric approach to digitalisation to address operational problems with digital technologies. They create a catalogue of digitalisation priority areas to help make digital manufacturing more accessible to manufacturing SMEs.

SMEs frequently fail to recognise the potential strategic benefits realised if Industry 4.0 was implemented. It is because of a lack of resources and an Industry 4.0 strategy (Horváth & Szabó, 2019; Masood & Sonntag, 2020; Moeuf et al., 2018, 2020; Sahi et al., 2020; Stentoft et al., 2020). Little or no automation in value creation processes and non-standardised processes in SMEs have been found to impede Industry 4.0 implementation (Müller et al., 2018; Stentoft et al., 2020).

Transitioning to Industry 4.0 necessitates more change in change management, supportive culture, supply chain integration, and data transparency across the entire value chain. These factors prove to be especially difficult for SMEs due to existing value creation logic and business models (Ghobakhloo, 2018; Moeuf et al., 2018, 2020; Müller et al., 2018, 2020). SMEs are being presented with numerous opportunities as a result of digitalisation. Even though SMEs face significant challenges in capitalising on the potential of digital transformation, mainly due to a lack of qualified staff in this area. This causes fear of change and job losses, which necessitates adequate change management processes and culture, frequently lacking in SMEs (Cimini et al., 2020; Khanzode et al., 2020; Raj et al., 2019). Hulla et al. (2021) attempted to identify challenges, staff competencies, and skills required to implement digitalisation in SMEs successfully. They conducted semi-structured interviews with industry representatives – CEOs, production managers, interest representatives, and consultants.

Stoldt et al. (2018) discuss how digital tools enable decision-makers to fully evaluate digitalisation measures during the planning process to

exploit newly available technologies. The combination of resources required to achieve a long-term competitive advantage must be accompanied by a corresponding managerial concept (Bhandari et al., 2020; Estensoro et al., 2021). Similarly, SMEs with a higher level of internationalisation can engage more effectively in their surrounding markets, networks, and ecosystems (Schmidt et al., 2020). Overcoming financial constraints, low bargaining power, and lack of market access requires an active strategy and the ability to network and acquire knowledge (Estensoro et al., 2021; Müller et al., 2021; Paul, 2020; Ricci et al., 2021). SMEs that can internationalise their operations gain a sustainable competitive advantage and are further ahead on the path to Industry 4.0 (Estensoro et al., 2021; Liñán et al., 2020).
The digitalisation of an enterprise is a fundamental requirement for companies to participate in this industrial revolution (Schuh et al., 2017). Not all types of digitalisation are aligned with Industry 4.0-related measures; simply digitising processes, while important, may not have the same impact on businesses as re-engineering processes after digitalisation. To that end, a digitalisation process should include Industry 4.0 Design Principles to be considered (Amaral & Peças, 2021). Because they provide a systematisation of knowledge and describe the constituents of an Industry 4.0 phenomenon, Design Principles (DP) explicitly address this issue (Gregor, 2009). Hermann et al. (2016) proposed the DP that comprise Industry 4.0.
There are assessment tools known as maturity/readiness models that can determine whether a company is eligible to participate in Industry 4.0 or the extent to which a company is engaged with it. These models are made up of dimensions that include sequential levels of maturity and the logical relationship between each successive stage. There are currently several maturity/readiness models available to assess a company's current commitment to the Industry 4.0 initiative (Amaral et al., 2020; Anderl & Fleischer, 2016). Ricci et al. (2021) examine manufacturing SMEs in Italy. They empirically test a framework that connects SME search strategies within their ecosystem to SMEs' ability to recognise digital opportunities related to Industry 4.0. Their

findings highlight the distinguishing characteristics of the knowledge search paths required to implement Industry 4.0 technologies in a small-to-medium-sized manufacturing setting.

2.3. The role of managers in the digitalisation

To remain competitive, SMEs must embrace digitalisation. To achieve a high level of digitalisation maturity, cultural dimensions such as roles and motivation, communication and education, strategy, and external compliance must be considered (Buchalcevova, 2015). Small and medium-sized enterprises (SMEs) should incorporate digital development into cultural dimensions such as vision and mission statements (Isensee, 2020). The progress toward the digitalisation of business necessitates a massive socio-technical transformation of organisational structures, strategies, IT architectures, methods, and business models. The digitalisation of business has impacted business dynamics, processes, routines, and skills. It is also worth noting that the success stories of digitisation have shown that the modernity of technologies and their IT decision makers and organisational culture play a critical role in implementing innovation (Nylén & Holmström, 2015).

The most common SMEs difficulties identified in the literature review are related to people's skill sets and the inherent intangibility of the Industry 4.0 concept and its constituents (economic benefit). Both digitalisation proposals presented in Amaral and Peças's paper (2021) address each of these obstacles. First, they accomplished that digitalising processes without changing employee working habits and utilising programs is impossible. They recommended using existing digital proficiency in the digitalisation process. Second, increasing the firm's productivity and production efficiency while avoiding earlier costly situations. In addition, „willingness to change“, which represents a lack of workers' willingness to change or openness to digitisation, and „financial benefits”, which means a lack of financial resources (Schumacher et al., 2016; Ganzarain & Errasti, 2016; Schuh et al., 2017; Griessbauer et al., 2016; Darnley et al., 2018), can be added.

Recently published studies on organisational learning for Industry 4.0 revealed a focus on managerial aspects, with no references to operational training for employees (Belinski et al., 2020; Moeuf et al., 2018). Technology surveying techniques are one strategy to overcoming the lack of technological awareness. These techniques provide an overview of digital technologies and their capabilities. Many publications refer to these solutions (Jordan et al., 2017; Ghobakhloo, 2018; Chiarello et al., 2018; Klingenberg et al., 2019). Mittal et al. (2018) assess various methods in their suitability for SMEs. In addition, a comprehensive framework customised to SMEs is proposed (Mittal et al., 2020).

According to previous research, top management support is critical for the digital transformation, as it is the executive team creates the necessary context and provides resources (Cortellazzo, Bruni & Zampieri, 2019). The digital transformation means a changed decision-making context and unprecedented challenges for top managers, considered the firms' key decision-makers. Indeed, given the novelty of the digital transformation, top executives cannot rely on traditional approaches, necessitating a thorough assessment of the firm's situation to develop tailored responses (Wrede et al., 2020). The managers are responsible for shaping positive attitudes towards digitalisation (Isensee et al., 2020). Top executives respond to the challenges posed by the digital revolution in three ways: understanding digitalisation, establishing a formal context for digitalisation and leading change (Wrede et al., 2020). Although digitalisation affects entire organisations, CIOs and IT managers are unsure how to deal with the challenges.

The influence of leaders on digitalisation in the organisation has been examined in numerous papers (Isensee et al., 2020; Schwarzmüller et al., 2018; Sullivan et al., 2015; Lee 2009). Leaders play critical roles in the development of digital culture. They must build relationships with numerous and dispersed stakeholders and focus on enabling collaborative processes in complex settings while addressing pressing ethical concerns (Cortellazzo et al., 2019). The role of leadership has become critical in capturing the actual value of digitalisation, particularly in managing and retaining talent, connecting and motivating people (Harvard Business Review Analytic Services, 2017). Much of the recent academic and professional interest in digital transformation and enterprise systems has focused on technology or the external forces of organisations, neglecting the importance of internal factors, particularly employees (Kozanoglu and Abedin, 2021). The existing literature primarily focuses on relationships with customers while ignoring the role of digital workforce skills in this process (Nadeem et al., 2018). The growing prominence of digitalisation in public discourse and the increasing pressure on firms to adapt to new market conditions highlighted the need for expanding theoretical knowledge of management's role and practices in digital transformation. Because people make companies work, the mismanagement of digital forces could harm the relationship with employees.

According to the studies, the most difficult challenge in many organisations undergoing digital transformation and innovation is reimagining the employee experience and bringing their digital literacy up to date. Employee interaction with technology is thus influenced by their ongoing personal and social assessment of and perception of fitness with the technology, which collectively forms organisational affordances at the group level. According to Murawski and Bick (2017), the main challenges for organisations are adapting their culture, mindset, and competencies to the new digital way of working rather than technological trends, disruptive innovations, or new customer behaviour. The shift to culture, perspective, and competencies necessitate focusing on employees. Employee experience practices will not create a personalised, compelling, and memorable environment for employees if employees are not prepared for these types of digital technology applications. Instead, it will result in information overload and anxiety among employees (Bawden and Robinson, 2009).

This study explores how readiness for digital innovations is distributed among managers and employees and whether their perceptions and readiness significantly differ. The results should be a good base to determine how top managers respond to and facilitate the firm's digital transformation.

3. METHODOLOGY

Data collection for this research was performed by the survey method. The survey was conducted through an online platform and direct contact with respondents. The questionnaire was created by members of the team of researchers engaged in the Visegrad Fund project. The survey consisted of six groups of questions. The first group refers to the demographic characteristics of the respondents and general data about the company where they work. The second group of questions examines the manner and degree of application of digital technologies in business and the attitude of respondents towards them. The third and fourth groups of questions deal with examining benefits and limitations in the process of digitalisation from the perspective of respondents. The fifth group of questions refers to the concept of Industry 4.0, while the last, sixth group of questions relates to respect for the principles of sustainable development in business. This international research was conducted in Hungary, Poland, Slovakia, Bulgaria and Serbia. A database of a total of 447 correctly completed questionnaires was created. The target group were owners, managers and employees in small and medium enterprises.
Following the research problem, the analysis includes one question from the first group, which examines respondents' position in the company in which he is employed. In addition, six subgroups of questions were selected within the second group: Use behaviour (UB), Attitude towards digitalisation (AD), Self-efficacy in digitalisation (SE), Anxiety regarding the digitalised working environment (ADE), Performance expectancy (PE), Effort expectancy (EE). These groups consist of statements in which the respondent should express the

degree of agreement with them by selecting the number on a five-point Likert scale. In this case, number one indicates complete disagree and five complete agree with the specific statement.

4. RESULTS AND DISCUSSION

4.1. Descriptive statistics

The results of the descriptive analysis for the question *Your position in the company* are presented in Figure 1.

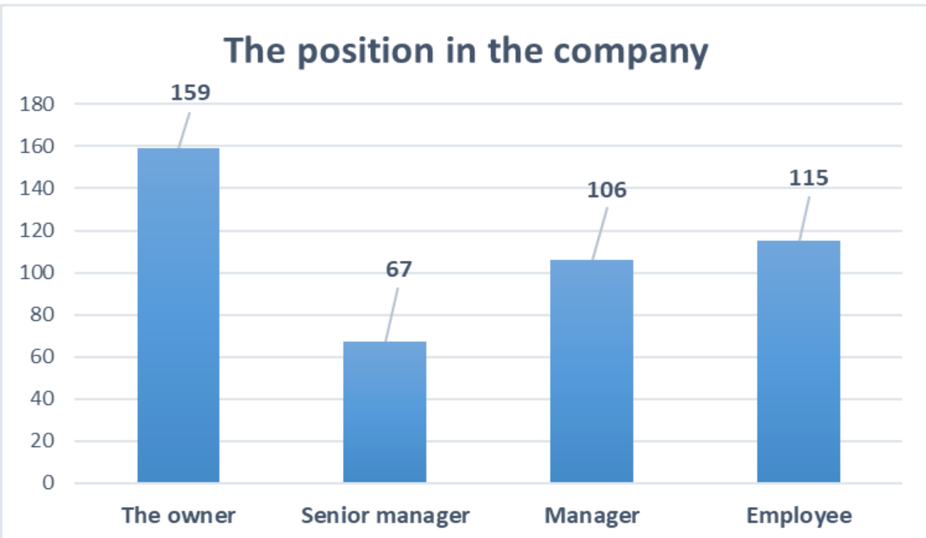

Figure 1. Descriptive statistics for the question "*The position in the company"*

According to the graph, most of the respondents (159) are the owner of the company, followed by employees (115), managers (106) and senior managers (67). Table 1 presents the summary of the descriptive statistics for each group of the questions.

Table 1. Descriptive statistics for the groups of the questions

		MEAN_ BI	MEAN_ UB	MEAN_ AD	MEAN_ SE	MEAN_ ADE	MEAN_ PE	MEAN_ EE
N	Valid	447	447	447	447	447	447	447
	Missing	0	0	0	0	0	0	0
Mean		3.24	3.57	3.74	3.59	1.92	3.88	3.86
Median		3.00	3.67	3.80	3.75	1.50	4.00	4.00
Std. Dev.		1.273	1.153	1.002	1.072	1.013	1.025	1.009
Variance		1.621	1.330	1.004	1.149	1.027	1.051	1.019
Skewness		-.196	-.410	-.596	-.534	.929	-.802	-.666
Std. Error Skewness		.115	.115	.115	.115	.115	.115	.115
Kurtosis		-.986	-.757	-.251	-.330	-.141	-.049	-.274
Std. Error Kurtosis		.230	.230	.230	.230	.230	.230	.230
Sum		1449.3	1594.7	1670.2	1603.5	860.0	1734.7	1725.8

Based on the mean values of the answers calculated for each observed group of questions (Figure 2), it can be noticed that the highest degree of agreement of the respondents with the statements from the groups of questions *Performance expectancy* (3.9) and *Effort expectancy* (3.86). Mean values for other groups of questions are close to this value, except in the case of *Anxiety regarding digitalised working environment*, where the mean value of answers is relatively low (1.92).

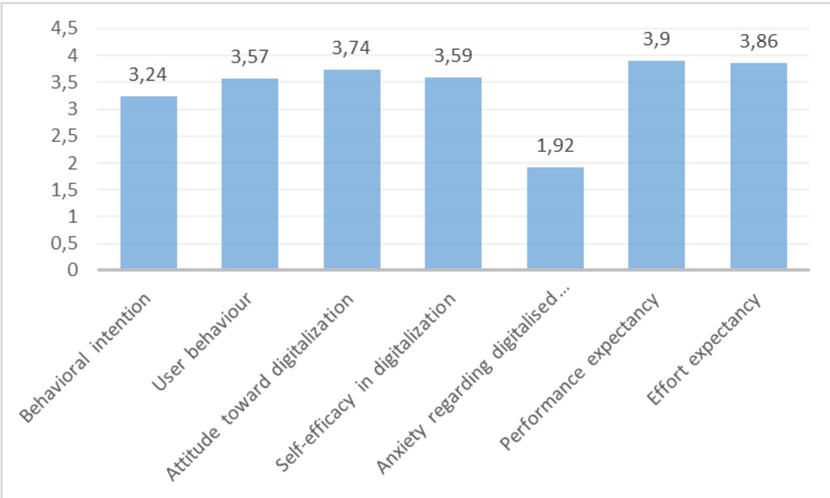

Figure 2. Mean values for groups of questions

The high average values obtained for the groups of questions *Performance expectancy* and *Effort expectancy* indicate that respondents have high expectations of improving business performances that would be achieved thanks to digitalisation. They believe that progress caused by the implementation of digital technologies will be made both at the organisational level and at the individual level. In their opinion, digitalisation significantly contributes to increased efficiency and effectiveness in conducting business activities. We can say that employees' awareness about the benefits of digitalisation is at a satisfactory level, although there is still space for improvement in this regard.

In order to compare the values of the arithmetic mean for each statement from the groups of questions that stand out, a descriptive analysis was performed, and the results are shown in Table 2.

Table 2. Descriptive statistics of the items from the PE and EE groups of questions

		Item	Mean	Std. dev.
Performance Expectancy (PE)	PE_1	I would find digitalisation useful in my job.	3.96	1.10680
	PE_2	Using digitalised processes enables me and the company to accomplish tasks more quickly.	3.97	1.12222
	PE_3	Using digitalised processes and services increases productivity.	3.98	1.13320
	PE_4	Investing in digital technologies enable cost-effectiveness.	3.87	1.14280
	PE_5	Digitalisation impacts the profit and performances of the company.	3.84	1.19329
	PE_6	My good digital skills increase my chances of getting a raise.	3.63	1.28492
	PE_7	Digital technologies are useful for my business during the COVID-19 pandemic.	3.92	1.26801
Effort Expectancy (EE)	EE_1	My interaction with the digitalised working environment would be clear and understandable.	3.87	1.10541
	EE_2	It would be easy for me to gain digital skills to work in the digitalised working environment.	3.86	1.12393
	EE_3	I would find digitalised working environment easy to use.	3.95	1.09290
	EE_4	Learning to operate digitalised processes is easy for me.	3.76	1.17082

The results indicate that in the group, PE is the highest degree of respondent's agreement with the statements PE_3, PE_2 and PE_1, where the mean values are almost equal and close to the grade 4 (3.98,

3.97 and 3.96, respectively). In the group of EE questions, the statement EE_3 with an average value of 3.95 stands out as the statement with the highest level of agreement.
On the other hand, the results of descriptive statistics for the group of questions *Anxiety regarding digitalised working environment* indicate the most significant disagreement of respondents with the belonging statements (Table 3).

Table 3. Descriptive statistics of the items from the ADE group of questions

		Item	Mean	Std. dev
Anxiety regarding digitalised working environment (ADE)	ADE_1	I feel apprehensive about digitalisation	1.93	1.1353
	ADE_2	It scares me to think that I could make multifunctioning in the digitalised working process by hitting the wrong button.	2.01	1.1875
	ADE_3	I hesitate to work in the digitalised environment for fear of making mistakes I cannot correct.	1.96	1.1416
	ADE_4	Digitalisation is somewhat intimidating to me.	1.79	1.1375

The analysis of the formulation of the statements leads to the conclusion that a higher degree of disagreement with them (lower value) is associated with a reduced Anxiety regarding digitalisation among respondents. We can say that the low average value, in this case, is encouraging because it speaks in favour of the fact that respondents do not have an intense fear of using digital technologies in everyday business practice.

4.2. Correlation analysis

In order to examine the existence of a connection between the position of respondents in the company and the answers to questions from the field of digitalisation, a correlation analysis was conducted (Table 4). Based on the value of Pearson's coefficient, the correlation between all groups of questions with each other was confirmed. The exception is the relation between ADE and SE. Let's analyse the variable The position in the company. A positive correlation is recognised with questions from BI, AD, PE, EE groups. In contrast, the answers to the questions from the groups *Use behaviour*, *Self-efficacy* and *Anxiety* do not correlate to respondents' position in the company.

Table 4. Correlation analysis

		The_position_in_the_company	MEAN_BI	MEAN_UB	MEAN_AD	MEAN_SE	MEAN_ADE	MEAN_PE	MEAN_EE
The_position_in_the_company	Pearsons	1							
	Sig.								
	N	447							
MEAN_BI	Pearsons	**.154****	1						
	Sig.	.001							
	N	447	447						
MEAN_UB	Pearsons	.062	**.571****	1					
	Sig.	.192	.000						
	N	447	447	447					
MEAN_AD	Pearsons	**.115***	**.612****	**.641****	1				
	Sig.	.015	.000	.000					
	N	447	447	447	447				
MEAN_SE	Pearsons	.090	**.119***	**.150****	**.296****	1			
	Sig.	.058	.012	.001	.000				
	N	447	447	447	447	447			
MEAN_ADE	Pearsons	.067	**-.188****	**-.215****	**-.338****	.044	1		
	Sig.	.157	.000	.000	.000	.350			
	N	447	447	447	447	447	447		
MEAN_PE	Pearsons	**.226****	**.616****	**.624****	**.798****	**.275****	**-.263****	1	
	Sig.	.000	.000	.000	.000	.000	.000		
	N	447	447	447	447	447	447	447	
MEAN_EE	Pearsons	**.140****	**.490****	**.562****	**.659****	**.225****	**-.343****	**.725****	1
	Sig.	.003	.000	.000	.000	.000	.000	.000	
	N	447	447	447	447	447	447	447	447

***. Correlation is significant at the 0.01 level (2-tailed).*
**. Correlation is significant at the 0.05 level (2-tailed).*

4.3. Discriminant analysis

Discriminant analysis (DA) is a multivariate technique used to classify observed variables into one or two alternative groups based on a

specific set of measurements. This analysis can also be used to determine the variables that contribute to the classification. One of its tasks is to graphically, or algebra describe the differential features between observations of different sets (Johnson and Wichern, 1992; pp. 575). Therefore, DA can have predictive and descriptive roles.
The covariance matrix within group j can be expressed as follows:

$$S_j = \frac{1}{n_j - 1}(X_t - \overline{X_j})^T (X_t - \overline{X_j}) \tag{1}$$

Where: X_t - set of training data from *n* observations and *p* variables in n_g groups; $\overline{X_j}$ - ordinal vector of the mean value of the sample of the j^{th} group and n_j - the number of observations of the j^{th} group.
In this research, the linear „stepwise“ method was used, characterised by Mahalanoby's measure of distance. For x_i observations in the j^{th} group, it amounts:

$$d_{ij}^2 = (\mathrm{X}_i - \overline{X_j})\mathrm{S}_j^{-1}(\mathrm{X}_i - \overline{X_j})^T \tag{2}$$

The linear discriminant function, also known as the Fisher's linear discriminant function, can be calculated as follows:

$$b_j = S^{-1}\overline{X}_j^T \tag{3}$$

where the vector b_j corresponds to the *p*.

The result of the training data classification is summarised by comparing the obtained and predicted groupings. The rate of misclassified cases is calculated based on the percentage of misclassified observations weighted by previous group loads:

$$E = \sum_{j}^{n} = 1^{e_j.\pi_j} \tag{4}$$

where e_j is the percentage of misclassified observations for the j^{th} group.
The efficiency of discriminant functions can be checked by applying the method of cross-validation, which determines the degree of predictiveness of the observed sample from which the model was created. Also, efficiency can be verified by a new data set used in

conjunction with a cross-validity model to evaluate the performance of set functions (Johnson & Wichern, 1992: 599).

In order to identify the statements that best reflect the differences in the degree of agreement depending on the respondents' position, a discriminatory analysis was conducted. Analysis of this type is most often used to set up a prediction model. The issues considered are those that belong to the groups with the highest correlation with the respondents' workplace. Therefore, 19 statements were singled out and subjected to this type of analysis. The standard, forward stepwise and backward stepwise methods were used to set the discriminant functions. The stepwise forward approach of the discrimination model is developed step by step. At each stage, all variables are reviewed, and discriminatory ones are evaluated. For taking the step back, the Backward stepwise method is used. In this way, the variables that contribute the least to prediction are eliminated. As a result of the successful discriminatory function, the variables that have the most significant impact on the division into groups remain.

In this analysis, four different positions of respondents in the company (The owner, Senior Manager, Manager and Employee) were marked as dependent variables, while independent variables consisted of statements that stood out by correlation analysis (19 in total). In the tables, the discriminant functions and classification matrices obtained from the standard, forward and backward stepwise method DA, are presented. The validity of each discriminant function was performed using Wilk's lambda test. On that occasion, the values of this coefficient range between 0 and 1 (0.785, 0.815 and 0.936, respectively) were obtained for the mentioned methods. That speaks in favour of the fact that the applied methodology is valid and effective (Table 5).

Table 5. Discrimination coefficients

	Wilks' Lambda	**F**	**Sig.**
Standard mode	.785	1.877862	p < .0001
Stepwise mode	.815	2.778135	p < .000
Backward mode	.9364899	10.01434	P < .0000

The standard model applied to the 19 analysed statements constructed discriminatory functions - DFs (Table 6), to which approximately 46.3% of correctly assigned cases were assigned (Table 7). In the next step, using the forward stepwise modality of discriminatory analysis, 11 statements were included from the initial 19 (Table 6), with a hit ratio of 40.7% (Table 7). Backward stepwise modality yielded classification matrices with 37.1% of correctly classified cases and one discriminatory statement. Discriminatory analysis indicated that out of the starting 19, there is only one statement in which, based on the answer (the level of (dis) agreement), the respondents' position in the organisation can be best predicted. It is a statement that belongs to the group of questions marked as *Performance expectancy* and reads: *Digitalisation impacts the profit and performances of the company*.

Table 6. Classification Functions: grouping - The_position_in_the_company

	Standard mode				Forward stepwise mode				Backward stepwise mode			
Item	**Owner**	**Manager**	**Senior**	**Employee**	**Owner**	**Manager**	**Senior**	**Employee**	**Owner**	**Manager**	**Senior**	**Employee**
BI_1	-0.281	0.006	-0.411	-0.209	-0.184	0.095	-0.305	-0.151				
BI_2	0.321	-0.037	0.633	0.672	0.215	-0.119	0.512	0.548				
BI_3	0.051	0.374	0.015	-0.045	-0.095	0.254	-0.143	-0.215				
AD_1	1.574	0.801	1.125	1.320	1.77	1.19	1.398	1.624				
AD_2	0.519	0.874	0.715	0.829								
AD_3	-0.002	-0.284	0.168	0.001	0.012	-0.096	0.226	0.084				
AD_4	-0.557	-0.462	-0.637	-0.732								
AD_5	0.526	0.279	0.004	-0.069	0.609	0.375	0.108	0.032				
PE_1	-0.03	-0.208	-0.128	-0.477								
PE_2	-0.003	0.309	0.156	0.244								
PE_3	1.061	0.892	0.982	1.15								
PE_4	-0.102	0.376	0.247	0.156	0.342	0.860	0.741	0.653				
PE_5	-0.722	-0.568	-0.157	-0.297	-0.293	-0.088	0.330	0.226	2.572	2.857	3.057	3.070
PE_6	0.095	-0.095	-0.07	0.151	0.333	0.186	0.209	0.436				
PE_7	0.238	0.386	0.365	0.479								
EE_1	0.694	0.403	0.871	0.617								
EE_2	0.454	0.742	0.657	0.726								
EE_3	0.704	1.074	0.096	0.725	1.501	1.854	1.116	1.602				
EE_4	0.127	0.095	0.47	-0.051	0.205	0.181	0.606	0.032				
Constant	-9.975	-11.789	-11.718	-12.032	-9.49	-11.238	-11.052	-11.31	-5.474	-7.378	-7.711	-7.685

Table 7. Discriminant matrix

	% Accuracy	**Position in the company**			
		Owner	**Manager**	**Senior manager**	**Employee**
<u>Standard DA mode</u>					
Owner	70.4	**112**	**3**	**13**	31
Manager	16.4	**31**	**11**	**8**	17
Senior Manager	31.1	**33**	**2**	**33**	38
Employee	44.3	**38**	**7**	**19**	51
Total	46.3	**214**	**23**	**73**	137
<u>Forward stepwise DA mode</u>					
Owner	66.7	**106**	**6**	**12**	35
Manager	7.5	**34**	**5**	**9**	19
Senior Manager	25.5	**35**	**1**	**27**	43
Employee	38.3	**44**	**3**	**24**	44
Total	40.7	**219**	**15**	**72**	141
<u>Backward stepwise DA mode</u>					
Owner	71.1	**113**	**0**	**0**	46
Manager	0.0	**47**	**0**	**0**	20
Senior Manager	0.0	**54**	**0**	**0**	52
Employee	46.1	**62**	**0**	**0**	53
Total	37.1	**276**	**0**	**0**	171

Based on this statement, it can be concluded that the perception of the impact of digitalisation on the profit and success of the company is significantly different depending on the organisational level in the company the respondent is. This result can be explained by the fact that the direct executors of work tasks, unlike the owners and managers, are not fully acquainted with the company's financial aspects and business results. The capital available to SMEs is insufficient for funding specific research activities, supporting modernisation, and expanding production capacities. Managers consider sources of borrowed capital and other smaller sources, as well as other smaller sources when making financial optimisation decisions (Panic & Voza, 2019). For this reason, employees cannot best assess the impact of the implementation of modern technologies on financial flows, profits and performances.

5. CONCLUSIONS

The digitalisation of the economy and its spread to all spheres of economic activity is associated with the emergence of problems during transformations and changes, which must undoubtedly be considered as challenges to the existing management system. The willingness of organisations to prevent the emergence of potential risks will ensure its long-term development and increase the expected efficiency and effectiveness in connection with digitalisation (Ivanova, 2019). Industry 4.0 enables SMEs to improve their manufacturing capabilities and compete globally.

Digitalization also opens up possibilities for industry-research collaboration (Arsic et al., 2014). Digital technologies have made companies feel trapped in their traditional ways of working. So, the profitable companies more frequently announce the calls for funding innovation projects in research and teaching indented for the universities and scientific institutes. They expect students and researchers to provide an outside-in perspective on digital opportunities in their industries and assist them in innovating and developing digital business models, products, and services. Technologies are becoming more user-friendly and accessible to researchers, and cloud services offer low-cost access to extremely powerful IT infrastructures. Because the barriers to implementing innovative concepts through prototypes based on cutting-edge technologies are lowering, research ideas and results are becoming more easily demonstrated. This allows one to make research more tangible by testing and collecting feedback on research ideas, evaluating research prototypes with larger user communities, and closing the gap between research, product development, and commercialisation.

Ensuring the effective implementation of digitalisation programs require large-scale transformations at all levels of the state and society. In this regard, it is best to use public-private partnership instruments, defined as a set of medium - and long-term interactions between the state and business to solve socially significant problems on mutually beneficial terms.

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DIGITALISATION AND AUTOMATION IN HUMAN RESOURCES MANAGEMENT AND EMPLOYMENT RELATIONS - CHALLENGES AND OPPORTUNITIES

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Abstract

The paper addresses the issues related to influence of automation on workforce and operations related to HR functions within a company. Automation and proliferation of technology have a lot of positive effects, but their certain aspects may be perceived as disruptive. There might be regional differences, but the position of large firms and those classified as SMEs varies significantly in a number of areas, including the “war for talent”. Additionally, competition has had a much wider scope in the era of globalisation and opportunities resulting from broad acceptance of distance work and availability of technological options, such as platform work. The changes have affected the workforce- skills, expectations, mind-set of employees, so that companies need to follow the trends and adjust processes in order to attract and retain talent in the organisation. Other macro- environmental factors, such as demographic challenges in certain regions, such as the EU, need to be met in a systemic manner to ensure synergy between different generations working together and smooth intergenerational transfer. The role of innovation in today’s economy should not be neglected in development of SMEs. Awareness of the factors that can contribute to their competitive edge should trigger development of strategies and applicable techniques to strengthen their position in economies. This can be achieved through focus on human resources management.
Keywords: *Human resources, Intellectual capital, Technological development, Talent acquisition, Skills imbalance*

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1. INTRODUCTION

The XXI century has been marked by an unprecedented pace of technological development which has influenced all areas of human existence. This provides for enormous potential for both economic growth as well as social well-being, but also poses numerous threats.
Knowledge based economy and globalisation have been seen as paradigms of the 21st century. The industries increasingly important for the economic growth and structure of employment are high-tech innovative sectors and those based on services. This has amplified the role of knowledge capital since the last decade of the 20th century. Knowledge capital consists of cumulated scientific knowledge (R&D) together with the level of knowledge of the society (level of education). Knowledge is the attribute of human capital and the only resource which accrues in the process of gaining experience. This resource is possessed and controlled by individuals and can thrive when favourable conditions stimulate its development. Therefore education and training on a regular basis in a form of Life Long Learning are crucial for carrier progression. The exponential pace of changes, in particular in technology, demands new skills to adjust to labour market demands.
In this new era, knowledge capital is a prerequisite of sustainable development which is a must taking into consideration resources depletion and the general damage caused to the environment by the activity of human beings. The Anthropocene - called the Human Age to underline the role and impact of a human being on the environment - originated in the late- 18th-century and developed along industrialization. Human activity has left significant footprint which will remain even after we disappear which makes it a part of the fossil record. “We have decisively changed the carbon cycle, the nitrogen cycle and the rate of extinction. We have created new atomic isotopes and plastiglomerates that may persist for millions of years. We have built megacities that will leave a durable footprint long after they have vanished. We have altered the pH of the oceans and have moved so

many life-forms around the globe - inadvertently and intentionally - that we are creating novel ecosystems everywhere" (New York Times, 2014).
The idea of the "World Shaped by Us" developed by D. Ackerman (2014) reflects the presumption that the natural environment depends on human factor to an unprecedented degree. At the same time human development has relied upon the nature and its systems. Through the process of evolution, species and systems detected ways to survive in natural environment, learned and adopted them. People look for inspiration to adopt the best solutions in numerous industries, such as construction, architecture or aviation, whose development is based on Biomimicry (Biomimetics).
In such setting businesses need to focus on human capital development which demands particular attention to HR management functions: identifying a person's natural skills, talent, personality and traits, offering a job that makes the most of one's potential, providing for conditions to enable advancement. Attracting, retaining, motivating and developing talented people can give companies a competitive edge.

2. TALENT MANAGEMENT

Talent management or human capital management has gained a new scope in the Global Village Era.
While everyone in an organization possesses certain talents, only a few people (about 5%) are „high flyers" who stand out, excel in their current roles, and have skills and knowledge to climb up to senior positions. Such people should be carefully managed through motivation programs, engagement and recognition.
In general, shifts towards service economy and its development which accelerated in the1960s demand specific skills to perform intangible tasks rather than manufacture things and businesses will increasingly depend on people who have them. Also, the changing make up of jobs available in the economy demands new skills, upgrading of skills and adjustment to changes.

Technological development contributed to polarisation of labour market which pictured as an hourglass represents a big number of top positions, knowledge jobs, high-skill, high-wage professionals together with entry-level, low-skill jobs (usually low wage), such as in care, hospitality, etc. The number of middle (wage) jobs is low while many new jobs for highly educated, highly skilled workers are available. As a result talent and wage gaps widened.
Digitalisation, apart from new forms of work organisation (such as platform work, automation of processes) brought about considerable potential in job creation for well-educated, highly skilled people, in particular in innovative, high-productivity sectors.
A frequently addressed spin off effect of technology proliferation is isolation, loneliness and stress. Business leaders are therefore expected to possess soft skills to create a friendly place to work and provide for employees happiness and satisfaction.
A study by Catalyst found empathy may have additional effect such as favouring innovation (61% of employees reported being able to innovate when having an emphatic leader), engagement (76% people who experienced empathy reported their engagement). Respect and understanding were reported to be a significant factor when considering a possibility to leave a company, thus representing potential in improving retention. Also inclusivity was combined with the fact that a leader was perceived as empathetic. Such leadership was found to be influencing the perception of work-life balance and support given in this respect by empathetic leaders (Van Bommel, 2021).

3. DEMOGRAPHIC AND GENERATIONAL CHALLENGES

In the light of demographic challenges the European economies have been confronted with, it is vital to consider their impact on employment. The percentage of very old citizens (80 +) is projected to more than double by 2080 (from 5.3% in 2015 to 12.3% in 2080) which implies declining working-age population will be paired with increasing numbers of retirement-age population. In the EU in 2030 people over 65 are expected to make up a quarter of the total population. The share of working age population is likely to decrease from 65.3% (333 mln) in 2016 to 55.6% (288.4 mln) in 2080, while the share of the elderly (people aged 65+) in the population of the EU is projected to go up from 19.2% in 2016 to 29.1% in 2080.

By 2030 already, there will be fewer than three people of working age for every dependent person over 65.

Such state of affairs translates into prolonged employment and age diversity of workforce. Resulting challenges will have to be met to enable synergy and smooth intergenerational transfer.

Moreover, contribution of older workers is going to be increasingly important, as well as their rejuvenation and rejuvenation. Job design and working conditions suitable for employees of different ages can make employment attractive. Research shows that so far little investment has been made in work situation of older workers, resulting in low esteem or support at work and limited opportunities of their employment.

Across the EU countries the demographic situation varies. In many countries the natural change (the number of live births less the number of deaths) in 2020 was negative, however in a number of them net migration was positive which mitigated the negative trend and resulted in overall positive change in population in 2021. Such trends have remained and are likely to replicate in the future. In the EU the negative change in population amounted to – 1,139.4 while migration amounted to 827.1 which translated into negative change in population between 2020 and 2021, but the effect of negative natural decrease in population was mitigated (Table 1) (Eurostat, n.d.).

Table 1. Demographic balance (thousands)

	Population in 2020	Natural change	Net migration and adjustment	Population in 2021
Czech Republic	10.693.9	-19.1	26.9	10.701.8
Hungary	9.769.5	-47.5	8.8	9.730.8
Poland	37.958.1	-122	3.9	37.840.0
Serbia	6.926.7	-55.2	0	6.871.5
Slovakia	5.457.9	-2.4	4.3	5.459.8

Source: Eurostat (2020)

Making the most of the labour potential in the circumstances should enable people to get employed and stay at work as long as possible. Labour market needs met in a sustainable way also mean that the most disadvantaged groups are educated and trained so that their skills and qualifications follow the altering expectations of employers. This refers in particular to women. older as well as young inexperienced people and those with disabilities. potential workers of migrant background. ethnic minorities who are vulnerable in terms of access to education. services and labour market in general.

Labour market is dominated by people who belong to generation Y (Millennials) and Z who, by 2025, are going to constitute 75% of the workforce. These two generations and their needs are therefore in the center of potential employers' attention. While their representatives from different countries and regions may vary, most of their core features have been found uniform across the world.

An interesting insight into preferences of different generations set against perceptions and expectations of different business sizes was provided by Sodexo. The research among 2000 adults in the UK showed 47% of Millennials consider SMEs as an ideal business size to work for, while 19% believe it is larger companies. There was a difference in loyalty demonstrated by the surveyed who stated they expect to be working for a big company over 5 years as compared with 4 years in an SME. One of the reasons may be difficulty in seeing a clear progression path (in particular after reaching senior positions) in small companies. and the added benefits that come with larger employers (Sodexo, n.d.). Interestingly among the values expected of small employers rather than big ones Millennials expect friendlier company culture and opportunity to get individual attention, resulting in customized training opportunities (Table 2).

Table 2. Benefits valued and expected in SMEs by Millennials

	Benefits valued by Millennials	Benefits expected more in SMEs than in big firms
Flexible working hours	60	43
Career progression	56	38
High salary	51	21
Friendlier company culture	33	79
Ability to work remotely	32	23
Individual attention. eg training	32	62

Source: Sodexo

Another research shows Millennials see opportunities of working on their own terms and taking on bigger responsibilities sooner rather in small businesses than in larger companies. 75% of the surveyed stated they want to work for themselves one day, so they expect to gain experience while working for a small business (Inc. Best Workplaces. n.d.).

The way Millennials do business differs significantly from previous generations in their use of intuitive technology skills. social media awareness and e-commerce acumen. Additionally. a bigger percentage of woman are small business owners (28%. ie 12% higher than the national average (Schroeder, 2021).

ManpowerGroup conducted a global study of 19.000 working Millennials and 1.500 hiring managers across 25 countries to understand the needs of Generation Y regarding work and to make projections about this group for 2020. The results show that Millennials tend to be demotivated by low pay and no development prospects which can make them leave the organisation. They value career security, flexibility, feedback and recognition by managers and colleagues, as well as variety and mobility and alternative work models. 93% of Millennials consider ongoing skills development as an important part of their future careers. They value work-life balance and a clear career path (Manpower. n.d.).

4. TECHNOLOGICAL DEVELOPMENT AFFECTING HR

In order to survive in the highly competitive environment. companies implement innovative solutions and technology to be able to compete commercially for customers and to attract talent to the organisation. Tools were designed to identify the right set of skills possessed by employees. Moreover, an image of a strong innovation leader perceived as attractive for potential employees. Employer branding of a trendy place to work can provide for a competitive edge as a technologically advanced, innovative, data-driven Industry 4.0 leader. Technological development, including digitalisation, machine learning, artificial intelligence (AI), data mining, Internet of Things (IoT), Blockchain technology, Big Data Analytics, has affected the way processes are carried out in every sphere of human life. They have also influenced management within areas which might have seemed to be dependent on human interaction and sensitive to human related assessment, such as HRM.
Cloud storing, voice generated commands, and e-mail functions, such as follow-ups are commonly used in business.
The Covid-19 pandemic has additionally accelerated the processes and led to even more profound changes. Both employers and employees were confronted with the need to learn and master processes online and elaborate on technology- supported task completion. Lock down and restrictions that followed made people use technology to an unprecedented degree so as a lot of companies have remodelled the way of work even after they were lifted or mitigated, not without advocacy of their employees. This has created an entirely new

foundation for development of technology based processes in the areas previously dominated by traditional approach.

Human resources management is at the heart of the transformation as people and technology have to interact, operate together, make the best of the synergy to maximise output.

Within business functions that seem particularly influenced by automation and AI is recruitment. According to a survey by LinkedIn. 76% of recruiters and hiring managers think the recruitment industry will be affected by AI and Automation to a high degree. Technological advances already serve to perform administrative jobs, such as screening resumes, processing CVs, planning interviews, or even creating online interview software. Candidates can be screened even through the lenses of their social media profile. Chatbots can analyse interviewees' answers including their word choice, speech patterns and facial expressions to determine their suitability for the role.

More than 50% of the interviewed talent acquisition leaders claim the biggest issue in their role is matching the right candidate to the best role. The technologies can also help in listing current employees' skills and attributes to match them to the currently available roles in a team (LinkedIn, 2018). Identification of new skills and capabilities that may be needed in the nearest future can accelerate and streamline the process of up skilling and retraining existing employees.

An example of automation applicable for HR functions is HRIS (Human Resources Information System) that collects, stores and processes employees' data in organizations. It provides for an automated employee data management, analyses remuneration and benefits selected to improve operational efficiency. The system also enables absence management (holiday, sick leave, time off) that is helpful in identifying its reasons and mitigating negative trends.

It is also used for automated and standardized record keeping and reporting. to accurately manage up-to-date information.

HRIS defines organizational structure, roles, functions and hierarchy to reflect the reporting system of the firm. Recruitment data are managed

to match the people with the right skills to the right functions in the right structure on an ongoing bases (Oracle, n.d.).
Challenges of such systems include employee data privacy and security because large amounts of sensitive and confidential data must be protected. Additionally, the system should guarantee every user who accesses the system gets exactly and only the information they need to perform a specific task without being able to access other information.
Moreover, data access rules must comply with regulations, which is particularly challenging to companies that operate globally. Activities performed through the system should not breach confidentiality or violate the law. Ongoing changes and continuous disruptive innovation mean that they need to be upgraded and refined accordingly.
Advancement in automation makes humans work alongside technology which poses the risk of dehumanization of the workplace. Ironically. in the HR arena, technological advancement is creating the opportunity to transform systems such as HRIS from an impersonal people-data management system to a system that creates a more human experience in the workplace. Systems can become intuitive with the use of AI and machine learning (ML) to “sense” what employees are trying to accomplish and proactively offer solutions (Oracle, n.d.). With access to more data smart devices might be able to make autonomous decisions and fully control certain processes, thus replacing a human. The smarter the technology, the more likely is replacement of a human in performing certain functions.
According to the BBC, human resource officers performing admin jobs have an 89.7% chance of being replaced by a robot, while the likelihood of human resource managers or directors to be replaced by robots is only 32.2% (BBC, 2015).

5. CHALLENGES OF INDUSTRY 4.0 FOR HR

While for industry 3.0 automation of single processes was typical, in industry 4.0 digitization covers activities from end-to-end.

Consequently, during the Fourth Industrial Revolution employees are more than ever aware that jobs they do may be taken over by robots or (AI) bots. Changes are driven by high speed mobile internet, AI and automation, big data analytics and cloud technology.

The Industrial Internet (Industry 4.0) refers to digitisation of horizontal and vertical value chains, offering digital products and services, operating connected physical and virtual assets, integrating analyses and use of data in all operations and internal activities (PwC, 2014).

The fourth industrial revolution involves the adoption of cyber-physical systems, such as the Internet of Things (network of interconnected smart devices that interact –send and receive data) and Internet of Systems (owned by businesses that can collect data from IoT networks to make independent decisions about certain business functions, such as sales or marketing campaigns).

New technologies and systems have a profound influence on the labour market, both positive and negative. Certain jobs will disappear in parallel with emergence of new roles and responsibilities, flexibility in employment will be expected and more specialist contractors might be needed. The global workforce will be allowed or encouraged to work from anywhere and benefit from lack of commuting, and better work-life balance.

The trend to Work from Home and/or Work from Anywhere is likely to strengthen as a side effect of the pandemic as people grew accustomed to the system and recognised its benefits. Systems based on Work from Anywhere are seen as enabling enlarging organization’s talent pool. They allow for employing workers who live in areas far from the company. The system is referred to as “secure borderless workspaces“or “talent on the cloud” and ensures every project is staffed by employees with the right skills, no matter where they are” (Choudhury, 2020).

Thus, technology enables lifting geographical barriers to recruitment and work. Implementation of AI platforms powered by HR experts provides for access to workforce ready to get involved in WFA system.

A survey conducted among senior finance executives from 187 countries showed they thought the Covid 19 pandemic has transformed their approach to hiring and workforce management. For 81% of them remote employees and Work From Anywhere model should be considered differently and adopted in global companies (Globalization Partners, n.d.).

According to the study by McKinsey Global Institute, about one-fifth of the global workforce will feel the effects of AI and automation. The most developed nations, such as the UK, Germany, the USA will be significantly affected. Half of the surveyed companies believed that by 2022 automation will lead to decrease in full- time employment and by 2030 robots will replace 800 mil workers in the world (McKinsey Global Institute, 2017).

Studies show, however, different areas are likely to be affected by automation with varied intensity. Job losses may result from robotics, machines taking over certain activities as well as professions disappearing.

Also, the influence of automation on workforce of individual countries will differ, for example jobs in Slovakia are twice as vulnerable as those in Norway. “In general, workers in rich countries appear less at risk than those in middle-income ones. But wide gaps exist even between countries of similar wealth”. (The Economist, 2018). The degree of risk of automation posed to particular business areas is shown in Figure 1. The results show robots can take over a lot of physical, predictable and structured jobs.

Robots will fail, however, in social, supportive roles or care. They lack human social intelligence, soft skills, such as empathy and cognitive abilities important in a wide range of tasks.

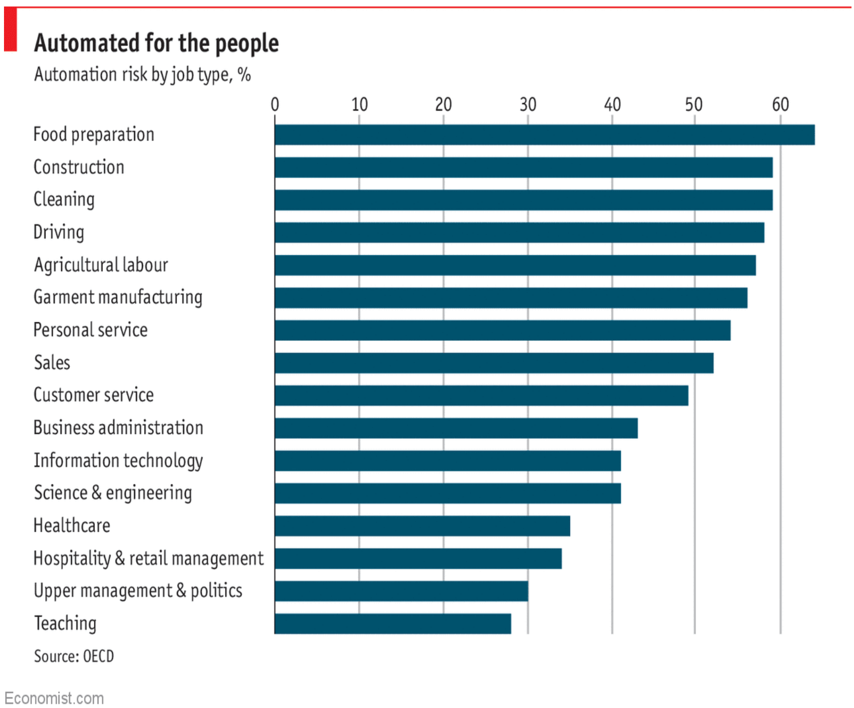

Figure 1. Risk of automation affecting different job types
Source: The Economist (2018)

In order to qualify jobs in terms of their susceptibility to automation a set of skills was determined that are necessary in performing them. The skills possessed by humans include: social perceptiveness, negotiation, persuasion, assisting and caring for others, originality, fine arts, finger and manual dexterity and the need to work in a cramped work space (Frey & Osborne 2013).

Simultaneously, technological changes should lead to new skills development which will be increasingly demanded by employers, such as teamwork, communication skills, managing project work in agile organisations. In order to make use of the potential of individual

employees, customised training and personal development programme should be designed.
Routine tasks can be automated and smart technology will generate changes in the proportion of human responsibilities and tasks carried out by algorithms. New jobs that will emerge and develop may include an app developer, social media marketer, data scientist.

6. EDUCATION AND TRAINING

The Bologna Process, including the Bologna Declaration of 1999 (implemented in 48 states), with particular focus on the European Higher Education Area and Life Long Learning (LLL) addresses the issues that should be prioritised in the context of socio-economic, demographic and technological challenges.
European knowledge societies need to pivot about constant improvement and updating of skills in the changing labour market, to ensure wider and more active participation of aging populations and their independence and well-being, maximise the potential and talent of all citizens.
Labour force with up-to-date skill set is the core of development and growth. Training should be provided to different groups of employees and in a variety of forms. High quality schooling systems and childcare can support and activate mothers, simultaneously fostering skills and providing for equal opportunities in children’s lives. Adults can benefit from continued investment in skills, qualifications and training that improves their competitiveness and chances for higher salaries, thus contributing to standard of living. Lower-qualified workers’ upskilling translates into improved productivity and performance. Higher qualifications and enrolment to studies may boost innovativeness. Broadened horizons, achievement, self-awareness and courage to reallocate are likely to contribute to employability.
Professionals notice that productivity can be improved if employees are managed as a portfolio, i.e. differentiated and developed individually and systematically. According to Myhrvold, the Chief

Scientist of Microsoft the top software developers can be even 10,000 times more productive than average ones. While this is not a rule in many professions, the difference might range from 20 to 50 times higher productivity in certain roles, in particular those knowledge-intensive (Becker et al., 2009).

Human capital, its education and skills determine an ability to innovate. The capacity of the economy to implement new technologies depends on the skills of its workforce and its level of education. It is also derivative of R&D expenditure and support of government institutions.

Competence development is strategic to business performance and success. In volatile and changing environment, recruitment and training must be strategically planned. However, adjustment is necessary to avoid staff being promoted and then stuck in a position following “Peter Principle”. Employees desire career progression and when they are promoted adequate training must follow. Otherwise at a certain point they reach the level of incompetence and cannot excel in the new role.

Adult (ages 25-64) education and training is viewed as increasingly important for the economic growth in the EU. While in the previous period the benchmark at the EU 2020 for adult participation in learning was set at 15 % during a four-week period preceding the survey, in 2021 the EU Council set a new target for the participation rate in adult education and training (in the 12 month prior to survey) of at least 47% to be reached by 2025.

The data collected for previous research show that adult participation in education and training (in the four weeks prior to the survey) varies significantly across the European countries, both EU and non-EU members. The highest numbers were recorded in Sweden and Switzerland where they stood at above 34 and 32 per cent respectively in 2019. The participation rate was high in other most developed economies with rates close to the previously set goal of 15%. However, in a number of European countries (Croatia, Slovakia, Greece, Serbia and Poland) the participation was very low - between 3% and 5 %.

In the decade of 2009-2019 a general increase in the participation of adults in education and training was observed. The EU-27 average rose from 7.9 % to 10.1 % in 2014 and to 10.8 % in 2019. However, as a result of the COVID-19 pandemic in 2020 this trend reversed, with the EU-27 average dropping to 9.2 %. With only a few exceptions, a decrease in participation in 2020 compared with the previous year was recorded.
Data sets illustrating participation in education and training within 12 months prior to the survey present more optimistic results: in 2016, 43.7 % of adults in the EU-27 took part, at least once, in education and training. "Twelve countries covered by this report registered at least 50 % participation, namely Switzerland (almost 70 %), the Netherlands, Sweden, Norway, Austria, Hungary, Finland, Ireland, the United Kingdom, Germany, France and Denmark (in descending order)". In other countries participation rates were at least 10 percentage points below the EU-27 average (North Macedonia, Greece, Serbia, Turkey, Bulgaria, Poland, Lithuania and Croatia (in ascending order).
Interestingly, differentiation between participation in formal and in non-formal education and training has been recorded. "Formal education and training refers to institutionalised, intentional and planned education that constitutes the formal education system of a country." As it leads to formal qualification, an important workload is required, while non-formal education usually takes the form of shorter courses and may lead to qualifications or certificates not recognised by the relevant national authorities as formal, or to no qualifications at all. Regarding formal and non-formal education and their features it is obvious very different participation rates are registered, for example in 2016 the EU-27 the average for non-formal education was around eight times higher than that of formal education (41.4 % and 5.0 % respectively).
Most of the countries where high overall rates were recorded (above the EU 27 average) also had relatively high rate of formal education and training with the highest rates reaching 10% above the average. The lowest participation rate in formal education and training was

recorded in Slovakia (1.5%), followed by Romania, Bosnia and Herzegovina, Lithuania, Czech Republic and Bulgaria (all below 3 %).
The study distinguished several country profiles with reference to proportion of low-qualified adults and their participation in education and training. Profile “B” which embraces the countries analysed (Czech Republic, Hungary, Poland, Slovakia and Serbia) includes also Belgium, Bulgaria, Germany, Ireland, Cyprus, Latvia, Lithuania and Slovenia. The typical feature of this profile is relatively low proportions of adults who have not completed upper secondary education (below the EU-27 average) in their populations and, at the same time, record low rates of participation of low-qualified adults in education and training (below the EU-27 average). Almost all countries in this group register relatively low proportions (below the EU-27 average) of adults who achieved an upper secondary qualification during adulthood (all except Germany and Ireland in certain aspects (European Commission, 2021).
As new ways of working are being developed and structured, new approach to pre-experience as well as on the job training should be considered. The needs of participants regarding learning are likely to evolve in parallel with their adjustment to new modes of work.
Providing distance work demands new skills such as communication based on technology. Such general skills should be paired with practical education and training relevant in a given position.
Learning opportunities, on and off the job training sessions, management development programs, distance learning programs should be parallel to provision of “time to de-stress”, entertainment, and fun activities to leave employees refreshed.

7. POTENTIAL OF SMALL AND MEDIUM-SIZED ENTERPRISES

Small and medium-sized enterprises (SMEs) are core in Europe's economy where they constitute a large proportion of all businesses (99% in the EU), including the countries of V4 and Serbia. There are

25 mln SMEs in Europe. Their role in the labour market should not be ignored as they employ around 100 million people, providing for 2 out of 3 jobs available in the EU.
However, innovation activities are only taken by 50% of all SMEs. Moreover, a quarter of them work on green products and services and only 17% of SMEs have successfully integrated digital technologies in their business, compared to 54% of large companies (European Commission, 2020). The European Commission in its strategy for a sustainable and digital Europe addresses SMEs of all sectors and sizes from traditional crafts to innovative start-ups.
SMEs face significant problems hampering development. While Single Market is open to SMEs products and services which benefits 80% of SMEs exporting products, exports outside the EU are only available to 600,000 SMEs. There are barriers, however, to exports of services.
78% of SMEs referred to complex administrative procedures as the biggest obstacle to operating in the Single Market.
Another important issue is financial situation of SMEs' because only 40% of businesses in the EU are paid on time. This is the cause of a quarter of SME bankruptcies.
Only10% of European SMEs' external financing is from capital markets. Similarly, only 11% of businesses in Europe consider equity as a viable financing option while only 1% have used it. Venture capital investments in Europe are many times smaller than in the US, with three times fewer scale-ups (European Commission, 2020).
Serbian economy is dominated by SMEs accounting for 99% of all enterprises. In 2018, SMEs in Serbia employed more than 65% of the labour force and accounted for 57.4% of total gross value added and for 37% of total exports. Sector-specific data indicate the biggest number of them (26%) operated in to the trade sector, followed by the manufacturing sector (15.4%), professional, scientific and innovative activities (12.8%), transportation and storage (10.0%). The numbers in table 3. show the particular role of micro firms in Serbian economy where they constitute over 96% of all firms. Together with small firms

they provide for nearly half (47.1%) of total employment (OECD, 2020).

Table 3. Firms of different sizes in Serbian economy

Firm type (no employees)	% of all firms	Number of employed	% of employment
Micro (1-9)	96.2%	432 968	31%
Small (10-49)	3%	225 030	16.1%
Medium (50-249)	0.7%	259 118	18.6%
Large	0.1%	478 630	34.3%
Total	100%	1 395 746	100%

Source: OECD (2020)

In Czech Republic in 2018 there were 1.155 mil active enterprises, of which 99.83% were SMEs. They employed almost 1.88 mil people, i.e. 57.68% of the total workforce. Micro firms dominated and constituted 96.4% of all SMEs. Their potential, despite an important role in creating jobs and development, is not entirely used as a result of insufficient collateral for obtaining loans/capital, limited resources to access information (on new technologies and potential markets), limited market reach, obstacles to entering foreign markets and insufficient innovative potential. (OECD(a), 2020).

Similarly, SMEs dominate the Slovak economy, accounting for 99.5% of the business (excluding self-employed individuals). The majority of them in 2017 were micro-enterprises that constituted 87.6% of all SMEs. They generated 54.6% of all value added and created 73.2% of jobs in private economy and 58.8 % in the whole Slovak economy (OECD(b), 2020).

In Hungary at the end of 2017 there were 724 000 enterprises, 99.86% (723 000) qualified as SMEs. The number of employed in SMEs amounted to 1 883 501 which constituted 68.8% of all employed and was even higher than the average in the EU (66.4%). Value added generated by SMEs in Hungary accounted for 53.7% of the total (in the EU 56.8%) (OECD(c) (2020).

Also in Poland SMEs dominate and account for 99.8% of all enterprises. Out of 2.08 mln of SMEs, microenterprises constitute vast majority (there were 2 004 288 micro-firms in 2017). Polish SMEs employed over 6.7 mln employees, which constituted 68.3% of all employment, and they accounted for 55.6% of value added (OECD(d), 2020).
According to ILO (2019) micro-, small and medium-sized firms together are responsible for over two thirds of all jobs worldwide and for the majority of new job creation. In numerous countries over 90% of all enterprises belong to SME category and a big proportion of these are micro firms. Such firms account for a large proportion of employment (Table 4).

Table 4. Employment in firms of different size (as percentage of all employed)

Category / Region	Self-employed (1 person)	Micro enterprises (2-9pers)	Small enterprises (10-49 pers)	Medium/ Large (50+ pers)
World	32.8%	23.1%	14.3%	29.8%
Europe and Central Asia	10	21.4%	25.8	42.8
Czech Republic	13.3	18	30.9	37.8
Hungary	6.9	25.1	27.2	40.7
Poland	14	19	24.3	42.7
Slovakia	10	32.4	37.9	19.7
Serbia	21.1	30.9	15.1	32.9

Source: ILO (2019)

The importance of SMEs varies accross countries and sectors. According to estimates globally they account for between 50 and 70% GDP generation. This contribution is particularly high in the service industry where the figure is estimated to stand at over 60% in nearly all OECD countries.
Despite the potential of SMEs demonstrated in their number and employment, it is large enterprises that can afford to invest in training or equipment. Therefore their bargaining position is stronger as for wages,

quality of employment and working conditions. According to (ILO (b), n.d.) large companies are estimated to have higher productivity, higher wages, they are more likely to be exporters, and to add new product lines and to adapt new technology.

Estimates show that large enterprises (100+ employees) are likely to pay double as much salary as small enterprises (of up to 20 employees) while medium sized enterprises (20-99 employees) are estimated to be willing to pay 43% more than small ones (ILO(a), n.d.). There are differences, however, across regions.

Among the challenges SMEs face most frequently quoted are: working conditions, productivity and informality. From the employers' perspective they also involve regulatory environment which is changing and unpredictable, limited access to finance (higher transaction costs and interest rates). Another important issue may be skills' shortage (at managerial and workforce level) and lack of resources to invest in knowledge and training. Limited financial resources, headhunting together with low employees' loyalty often translate into fewer chances of investment in workforce training. SMEs also have limited access to infrastructure, business and employer networks and resources to invest in technological solutions. For SMEs, digital technologies could potentially enhance management practices, improve market intelligence and create virtual access to regional and global value chains, thus solving many problems they face.

From employees' perspective the challenges include 20-30% lower wages than the national average, gender wage inequality (male and female owned SMEs), lack of social security in many low and middle income countries (with small number of staff they do not contribute to social security). Another issue is poor occupational safety and health as research shows that work environment is more hazardous in small firms. In Europe, 82% of all occupational injuries and 90% of all fatal accidents occur in SMEs. Poor industrial relations (in SMEs trade union membership is low and collective bargaining may not exist) determine security and working conditions (European Parliament, n.d.).

In 2018 PwC's Strategy& interviewed 1,155 manufacturing executives in 26 countries to examine and rank companies by digital operations maturity. Four groups were distinguished: Digital Novices, Digital Followers, Digital Innovators and Digital Champions. The study was based on an assumption that four essential ecosystems determine mastery in processes of digitization: Customer Solutions, Operations, Technology and People. These activities are tied and interconnected and constitute a network of digital relations and practices.

The highest level of digitization (typical of champions) was identified only in 10% of companies surveyed. The authors of the survey define their scope of digitized operations as far-reaching and far beyond automation and networking.

An interesting result was also presented regarding the regions that can be considered leaders of the transformation. While companies in North America and Europe led the way in the past, at present Asia-Pacific region has increasingly been leading the way to digitization.

Only a fraction of big companies and medium-sized firms embarked on the solutions that cover the whole system within the company while others only use certain, fragmented solutions (PWC, 2018). Firms that top the league integrate operation, technology and people ecosystem.

People ecosystem is the domain of organizational competence and culture, and includes skills, mind-set, behavior, relationships and skill sources, as well as career development, that are all found to support digital transformation.

The survey showed that most companies, even those that are aware of the importance of digital transformation, lack the vision, strategy and culture to support it. Two-thirds of the companies that took part in the survey were found to lack such vision. In contrast, at more than 70% of companies that qualified as Digital Champions, the leadership had a clear vision of the digital future and could therefore act as role model for the rest of the organization. In addition such companies invest heavily in training and developing the right skills for a digital environment and have succeeded in building a digital culture.

In the light of the discussed issues, the following SWOT analyses (Table 5) should summarise the potential of SMEs and challenges they face.

Table 5. SMEs' SWOT analyses

Strengths Agility Close relationship of staff members Opportunities of attention to detail and individual Focus and specialisation Relations with local communities Understanding of local needs. responsiveness	**Weaknesses** Limited resources and opportunities to scale up Dispersion Small scale limitations
Opportunities Potential employees priorities Support of European and local authorities Regulatory stability. predictability	**Threats** Competition of big players. global companies Limited access to finance Regulatory environment

Digitalization has paved the way for new ways of working, such as work via online platforms, as well as for the progressive automation of work. Digitalization is also associated with a significant potential for creation of jobs for well-educated, highly skilled employees, especially in innovative enterprises.

Taking into account human resources constraints caused by the phenomenon of aging population and scarcity of natural resources, growth across the EU must increasingly be based on changing the way of production and consumption patterns and improved productivity achieved through investment in human capital, in particular within SMEs sector.

According to the World Bank Report "the future of work will be determined by the battle between automation and innovation". As a result of automation, employment in old sectors declines. Simultaneously, thanks to innovation, new sectors or tasks emerge. The future of employment will depend on both automation and innovation and on the labor and skills intensity of the new sectors or tasks. "Automation has reduced the demand for less skilled workers, and the innovation process has generally favoured the more educated". (The World Bank, 2019). These trends are likely to affect wages and may contribute to further polarisation of the societies. The battle for talent between SMEs and large companies will likely intensify and the former should learn how to identify their chances to win it.

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DIGITALISATION IN INDUSTRY 4.0

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Abstract

Industry 4.0 is now a widely used term that is prevalent in contemporary economies when defining industries. In particular, advances in the digital sphere are enabling rapid growth and progress in a wide variety of industries. In particular, data is used for decision-making and further progress, which is a driving component for Industry 4.0. The present chapter aims to map and clarify the connections between Industry 4.0 and digitalisation in a wide range of segments and to highlight positive examples of the implementation of functional principles in practice. Industry 4.0 is becoming dominant in the present as well as in the future not only in the V4 regions but also in Serbia, especially in small and medium-sized enterprises.
Keywords: *Industry 4.0, Digitalization, Industry 4.0 principles*

1. INTRODUCTION

Industry 4.0 is a phenomenon of the present and the future. For a better understanding, here is a brief history of the concept and its progression in terms of the technological maturity of the world. The following sections are devoted to the industrial revolutions that have changed the understanding of world economies and brought certain paradigms, views on the production aspects of business entities (Janković et al., 2021).

2. INDUSTRY 4.0

2.1. History of Industry 4.0

The following historical cross-section demonstrates the shift from conventional manufacturing to the state-of-the-art concept of Industry 4.0 (Figure 1). It gradually clarifies the storylines from the first to the fourth industrial revolution.

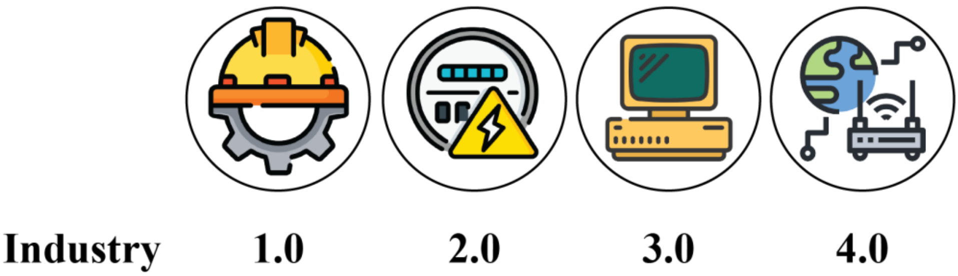

Figure 1. Industry 1.0 → 4.0

Before the name Industry 1.0 was applied, there was a period when craftsmen and all sorts of people alike struggled to produce products with basic tools. Often there was also commercialization, where products were brought to the market or into the commercial process. The above dates back to the 1760s.

A fundamental phenomenon occurred after that time when processes were invented that led to the commissioning of manufacturing machinery. Technological advances were led particularly in England, where innovation in the form of the introduction of machines appeared in the 1760s, and by the end of the 18th century, innovations had been transferred to the USA. From that point on, we can speak of so-called Industry 1.0. The industries that were most affected by machine innovation were mining, glassmaking, agriculture and textiles. The essential innovations were the spinning wheel, the steam engine and the water wheel. Another innovation was the updating of laws, especially in the lower working class, as it was not regulated especially for children, nor were there standards to protect workers (Winkler et al., 2021).

The second industrial revolution dates back to between 1871 and 1914. This period saw widespread innovation in the form of long-distance communication, faster transportation in the form of railroads, and a groundbreaking innovation in the form of the introduction of electricity to manufacturing. These innovations led people to spread new ideas more quickly among themselves. In the same way, the faster movement of people contributed to faster progress in all spheres. Production at that time was carried out on modern production lines, which included electrification. Technological innovation in production led to increased efficiency. Henry Ford is considered a major pioneer who fully developed the mass production of automobiles through the assembly line (Milošević, 2021). The Second Industrial Revolution was characterized by high economic growth and increased unemployment in conjunction with the replacement of workers by machines.

Further advances led to the Third Industrial Revolution, which dates back to the 1970s, where the transformation of machine production combined with automation is reported to have been partial. During this period, memory programmable controls and computers were the most widely used. The third industrial revolution is also referred to as the digital revolution (Du Preez & Sinha, 2021). The mass production and use of fitial logic, chips, integrated circuits and so on increased in that period. The innovations were not only in manufacturing but also in devices for people. The Industry 3.0 period is characterised by the use of computers for entertainment and work. The use of microprocessors, digital mobile phones and the Internet were coming to the fore. (Kusa & Piatrov, 2018). In marketing, changes in both production and business methods have been observed. Most significant is the shift from analogue to digital. It should be noted that most of the manufacturing sector is now in the Industry 3.0 phase.

The latest current concept is Industry 4.0, characterised by the combination of physical components with digital technologies. Digital technologies enable them to operate both locally and globally (Kusá & Urminová, 2020). The rise of the Fourth Industrial Revolution builds on the previous Third Industrial Revolution, where superstructure innovation technologies are evidenced in addition to computers. There is talk of advanced digital technologies, namely the Internet of Things (IoT), artificial intelligence (AI), robots, drones, 3D printing, self-driving cars, cloud computing, etc. Cross-device communication, data analytics and automated action are particularly important. Ultimately, the industrial boom is based on responsiveness, a smarter approach and more flexible decision-making. Data becomes the primary tool, which is processed, evaluated and then valorised in guiding the direction of companies. The following table offers a summary of the most significant innovations and the years when the paradigm of looking at the industry changed. Industry 4.0 was first made public in 2013 at a trade fair in Hannover, Germany, as a response by the German government. Already in 2011 it was used in a project in the concurrent strategy of the German government, to promote the computerization of production. Immediately after that year, companies started implementing it in real production and incorporating elements of Industry 4.0 (Xu, Xu & Li, 2018).

The following chapters are devoted to defining Industry 4.0 according to leading authors. The analysis provides conclusions which, on a theoretical level, form conclusions in the form of the future direction of business entities within Industry 4.0.

Table 1. Industry 1.0 → 4.0

	Industry 1.0	Industry 2.0	Industry 3.0	Industry 4.0
Change has occurred	1760	From 1871 to 1914	In the 1970s	2011
Radical Innovation	steam engine, spinning wheel and water wheel	rail and telegraph network, electricity	computer, microprocessor, digital mobile phones and internet	interconnection, IoT, AI, robots, drones, 3D printing, cloud computing

2.2. Definition of Industry 4.0

The following section discusses a number of perspectives on the definition of Industry 4.0 from leading authors and highly technical sources. Analyses of the definitions in the resulting comparisons are presented in turn.
According to the i-scoop portal, Industry 4.0 is currently in the trend of automation and concurrent data flow in manufacturing technologies, which includes cyber-physical systems, Internet of Things, cloud computing, machine learning and smart factory (I-Scoop, 2022). Some theorists point to a certain ideological indoctrination in the science of Industry 4.0. Industry 4.0 can be described as a new vector in the development of industry as a whole, as only some developing countries have contributed to its initial development. (Madleňák, 2020) This implies that Industry 4.0 has started to be created by developing countries that have sufficient resources and social platforms (Ambrozy et al., 2018). Industry 4.0 is an avenue that helps to saturate the labour market through skilled human resources to improve the educational system in the field of information and communication technology (ICT). The continuous expansion of Industry 4.0 should be instrumental to build job opportunities, thus avoiding unemployment and social inequality. The development of Industry 4.0 also brings with

it changes that arise due to the increasing demands for competencies and training of human resources, which also helps to the demand for training in various fields (Grečíková et al., 2021). Industry 4.0, according to Tseng and et al. (2021) is characterized by a technological concept that brings various innovations especially in the digital domain and combines physical and digital environments with cyber systems, which is terminologically referred to as CPS (Tseng et al., 2021).

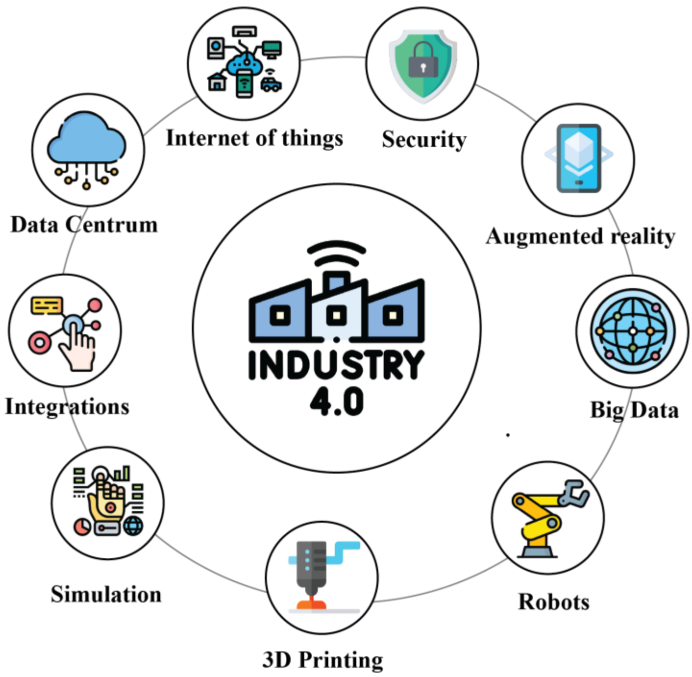

Figure 2. Selected Industry 4.0 technologies

In the context of Industry 4.0, it should also be noted that Industry 4.0, unlike the previous three concepts, has evolved as a result of the planning concept. As mentioned in the previous paragraphs, the development of Industry 4.0 originated in the territory of Germany. The main impetus for its emergence was precisely the impetus for a new industrial boom in Europe, as a result of which we are observing a

growing trend towards the development of digitalisation in a number of developed countries around the world.
The conclusions of the analysis of selected available sources show that Industry 4.0 has brought innovations in the interconnection of the digital and physical environments, which has been linked to the emergence of IoT, AI, robots, drones, 3D printing and cloud computing (Figure 2). Industry 4.0 is a major contributor to the fact that we are on the threshold of a technological revolution that is changing the way we live, learn, process technology and human relationships. The general essence of any revolution is to gradually replace human labour with machines, so as a result of digitisation (Madleňák & Žuľová, 2019) we can talk about the automation of various areas of production.

2.3. Industry Design 4.0

The following section defines the four design principles of Industry 4.0, these are as follows:

- Interconnection - of different devices through the Internet of Things or the Internet of People, which is ultimately connecting devices, sensors and the machines themselves based on the flow of data.
- Information transparency - a component that ultimately has an important role to play in decision making at both the managerial and production sections of a business. The data that emerges from different parts of the enterprise are further processed analyzed and conclusions are formed for decision making.
- Technical assistance - the systems facilities are formed in a technological spirit and aimed at providing the necessary human decision making especially in problem solving and to avert negative impact in difficult and dangerous tasks.
- Decentralized decision making - based on data evaluation and the ability to be as autonomous as possible is the domain of the

machines, elements and individual devices of the business entities. (Hermann, Pentek, & Otto, 2016).

2.4. Industry 4.0 principles

The foundation of Industry 4.0 is precisely the elements that together form a synergy. As the literature sources state the contents are two pillars and those are namely:

- digitalization (encompasses all sections of the business entity),
- the application of exponential technologies.

Not only digitalisation, but also the Internet of Things (IoT) is encroaching on people's lives. We can talk about the so-called "smart home", which is becoming increasingly popular. Similarly, businesses are bringing elements of the so-called "smart factory" into their production processes. The exact definition of a smart factory is that certain elements are interconnected, and these are products, logistics facilities, people and resources. All of these elements can communicate and cooperate together, leading to an abolutely networked internet. Whether it is an intranet or a global internet network. Collectively, all interconnections and tools are driven to exchange data for more efficient and faster decision making. The interconnection is intelligently monitored and transparent, and all involved members of the business entity have a constant overview for quick flexible reactions in terms of production and marketing activities (Lucke, Constantinescu & Westkämper, 2008).

Table 2. Categories of individual Industry 4.0 tools

Cyber Physical System - CPS
RFID
Cloud Computing
Digital Manufacturing
Exponential technologies
Product Lifecycle Management - PLM
Big Data
Digital Twin
Internet of Services - IoS
Internet of Things - IoT
Mobile Computing

The individual elements are analysed in more detail in the following lines. We look at each element of Industry 4.0 in detail and finally define the outcomes.

2.4.1. Cyber-physical systems (CPS)

The element in question is characterized by a significant degree of innovation, whereby the interconnection of physical devices with internal tools is forged so that data in digital form is transmitted, processed and connected through the Internet online. CPS have three characteristic factors, which are communication, computation and control. The above systems have significant factors that make Industry 4.0 into its final form. The most common example is the mobile phone, which has changed its original function from making phone calls to offering all sorts of functions (Letichevsky, Letychevskyi, Skobelev, & Volkov, 2017).

2.4.2. Big Data

Sets of data that are continuously or systematically collected and yet may tend to be large in scale or complexity. Thus, processing with conventional analytical tools is considerably inefficient or even impossible. On the other hand, new tools are continuously being created that are designed to collect, analyse, process and visualise data. Often in practice, the term Big Data is confused and people talk about predictive analytics and some advanced methods for extraction and prediction. The truth remains that big data can help in decision making processes and can be transformed into a variety of inferences after predictive, A/B testing, machine learning or processing into visual form to help business decision makers. In doing so, it is the technology of processing data packages that is important whether it is databases, cloud computing or business intelligence (Chang, 2021). Ultimately, proper visualization is also important, as processed data is often difficult to interpret, it is important to use visual communication and bring out the most effective graphs, charts and infographics. Once thoroughly analysed, data presents opportunities for growth in Industry 4.0. Businesses are enabled to analyze data from production factors such as sensory processing of vibration, pressure, current, voltage, etc. We see some parallels if updating processes from Industry 3.0. Sensors generate a large amount of data which is stored and evaluated after processing. This makes it easier, faster and, above all, more efficient for businesses to make decisions.

2.4.3. Internet of Things

The Internet of Things is the networking of physical objects especially devices, or machines, vehicles and other things that incorporate a specific kind of electronics, software and sensors that are connected to the network through a cyber-physical system. The Internet of Things is also observable in common appliances or equally so in industrial business entities. Devices or more precisely things that are connected to the internet can be monitored through the internet and can equally be controlled from anywhere in the world. The result is not only the level of control, but also the level of data that is collected and evaluated in many cases. Simple automation and autonomy is also possible through interconnection. The whole effort of interconnecting devices is defined by the respective efficiency, accuracy and economic benefit. Predictions for the distant future suggest interconnecting as many devices as possible through IoT (Li et al., 2021).

2.4.4. Internet of Services

Unlike the previous element, the Internet of Services is a plane that cuts across all elements of Industry 4.0. It is a structure that uses the Internet to sell services. With the help of IoS, services are a saleable commodity where a technical base is provided in which business models are used that focus on selling and delivering services. In particular, research, marketing, production, distribution, sales and development are essential. Cloud computing is a typical example where people can rent data storage anywhere in the world. On the other hand, e-commerce, enabling business collaboration between sellers and buyers, also ranks here.

2.4.5. Cloud Computing

The above term can be described as services and products that are available on servers via the internet. Potential users access it from virtually anywhere making the service highly admirable. (Murár , 2021) The user logs in to the service or application via a web browser and usually does not pay for the service, or pays for premium services or a subscription for a certain period. Most often these are specific software packages such as office applications, specialised software or storage. There are three service models:

- Software-as-a-Service (SaaS),
- Platform service - (PaaS),
- Infrastructure service - (IaaS).

Based on the above tools, businesses can run their day-to-day operations very efficiently, anywhere and anytime. In this way, there is a globalization of the overall process in production or other activities of business entities (Bello et al., 2021).

2.4.6. Digital Manufacturing

Prototyping and above all designing and testing is made possible by the above mentioned elements of Industry 4.0. Based on a computer program, simulation, plausible visualization or all sorts of analysis is possible before the actual product is put into production. From a marketing point of view, this is a highly innovative element that replaces a whole range of processes and replaces, for example, logistics, the production line, tools and a wide range of workplaces. In doing so, it is important to point out that it is the testing and simulation not only of the resulting products, but also of the production processes that can be improved or innovated on the basis of the analysis, with minimum costs without direct action in the production sphere. Digital representation is the way to completely new knowledge on how to optimize activities, and products so that specific operands are already defined during the planning process that can be implemented in the business entity (Papadopoulos, Singh, Spanaki, Gunasekaran, & Dubey, 2022). An example is the improvement of the user experience directly by consumers, as consumers generate data that can be translated straight into a design and then implemented into a variety of processes or products of the business entity.

2.4.7. Product Lifecycle Management Systems

The product life cycle is a widespread marketing as well as economic concept. Successful management is ensured thanks to Industry 4.0, where a system has been developed to manage the above phenomenon. Based on data from design solutions, features, production process and customer use, it is possible to handle processes, business systems as well as big data in the company's internal environment, but also in the external environment where suppliers and customers operate. The system translated into software enables efficient information management, which ultimately determines the prediction of the product life cycle from invention to product discontinuation from the product portfolio. System solution of the process, the so-called digital manufacturing tools for detailed mapping of the entire environment in the output with the content of quality management, maintenance management, or testing. In each part of the product production, data is present and directed to the system, and both partial and final results are transmitted in real time. The efficiency is increased and the impact on the company, external or internal environment is knowable and provides assistance for decision making (Singh, Misra, & Kumar, 2021).

2.4.8. Digital Twin

A digital twin can be described as a digital offshoot of a physical object within production. The established duplicate can then be used for a variety of either tests or diverse simulations by collecting data from sensors that interact directly with the physical object The main parts are the tangible physical product, the virtual duplicates of the product, and the data collection that links the digital and real product. In doing so, the essence is precisely in the creation, testing and conclusion of the analysis of such twins. It is important to note the interdependencies that bind to the duplicate. If the physical counterpart changes, so does the digital form. For this reason, optimisation is highly efficient and fits into the Industry 4.0 concept. Authors Lee, Cameron and Hassall state that the digital twin of an entity helps to understand, learn and reason about the unfolded parts or the whole life cycle of an entity. It is important to note that in general there is a distinction between product digital twins (representing what is produced) and process digital twins (these are the devices that are used in production). In the context of digital twins, it is also useful to define the term digital thread, the two entities of the twin connecting and helping to make the digital twin useful throughout its entire life cycle.

We are also familiar with the "meta digital twin", which links all digital models using semantics and as a result of the interaction between the two digital twins, better synergy can occur (Lee, Cameron & Hassall, 2019).

2.4.9. Exponential technologies

Represents certain specific technologies that facilitate processes and day-to-day operations for business segments. Specifically, these include biotechnology, drones, neurotechnology, advanced robotics, new energies, 3D printing, sensing, artificial intelligence, etc. Some of the technologies bring new opportunities not only within business entities, but also a wide range of applications in the sphere of marketing. We can also find some drawbacks in the form of fears as many digital devices can eliminate the activities of people who have been in the production process (Mashelkar, 2018). Industry 4.0 also involves the changing of human workplaces, where a number of authors talk about the possibilities of retraining or re-educating the current workforce to new ones that are created thanks to Industry 4.0.

2.4.10. RFID

Represents the wireless contact use of radio frequency waves that can be used to transmit data. RFID takes auto-ID technology to a new level, as it allows tags to be read without having to see them directly. With RFID, it is possible to read over a range of a few to more than 20 centimeters depending on the specific type. A historical cross-section shows that this technique was already known in the Second World War. Using RFID, soldiers could identify whether an aircraft was enemy or allied. Its role in digital transformation is a fully digitized view of a particular process. There are several types of different RFID formats, from an industry perspective we can give a breakdown by the frequency it operates on and by the physical distribution format. The classification into passive, active and visual RFID is also well known.

At the digital transformation level, passive RFID comprises a tiny chip the size of a single grain of sand that is driven by high frequency transmission energy sent by the device attempting to read it. It brings a cost-effective approach to digitizing asset flow and generating useful data for processes. Active RFID has an internal power source, and usually an inexpensive battery that is designed to be functional for 5 years. It allows visibility over greater distances than passive RDIF and records temperature, motion alarms and magnetic safety interlocks (Motroni, Buffi, & Nepa, 2021). This digital transformation mechanism helps enterprises in digital transformation and achieving better results in various areas.

2.4.11. Mobile Computing

It represents various devices that open access to data and information from anywhere. According to several authors, the mobile computing mechanism works on the principle of mobile computing, which provides data, videos and images through a mobile device. These devices can be connected to a LAN (local area network) or they can connect through Wi-Fi and hence take advantage of the wireless local area network (S. Malik, Akram, Gill, Pervaiz, & H. Malik, 2021). Mobile devices have undergone an evolution and now have functionalities such as facial recognition, virtual reality, augmented reality or various interactive applications. However, all of these functionalities are data processing and storage intensive. As a result of the resource load, they need to be lightened as much as possible by automating the use of resource-intensive applications. Due to the increasing use of smartphones globally in areas such as entertainment, healthcare and e-learning, e-business, there is a need to offload computing intensive tasks. A new approach is MCC, which combines a combination of CC (Cloud Computing) and mobile computing.
A deeper connection is discussed in the next chapter, which deals with the link between digitalization and Industry 4.0 as a driving force behind the defined concept.

3. LINKING DIGITISATION AND INDUSTRY 4.0

Industry 4.0 represents a new paradigm for the economy in a global sense. (The digital transformation of industry is generally based on the following four pillars:

- Digital data (through which data can be collected and processed resulting in data that can be analysed),
- automation to provide cognitive products and environments (based on automation, it is possible to provide cognitive products and environments that are able to operate autonomously),
- connectivity synchronisation of supply chains, which should lead to shorter innovation cycles,
- digital access provides customers with greater transparency and new services (Armengaud et al., 2017).

The introduction of digitalization is the result of a process of negotiation and social interaction during which different actors at the level of the organizational hierarchy of the field legitimize the sequence of steps. The digitization of information is a fundamental element that conditions the implementation of the strategy in Industry 4.0 as a component of Smart Industry. In the context of large-scale management of production technologies, we are talking about demanding processes that are easier to process thanks to digitisation. In the following section, we present some perspectives on the issue of digitalization in relation to its connection with Industry 4.0.

3.1. Digitalisation vs. Digization

The term digitalisation generally refers to the digital transformation of two variables - society and the economy. In the context of digitisation, we often encounter terms such as digital technology and digital innovation. It is important to clarify the difference between digitisation and digital transformation. According to the authors Caputo et al. the term is used in the context of creating digital (bits and bytes) versions of analogue, or in other words physical things such as paper documents, pictures, sound recordings and various others. Digitalization represents a broad socio-technical process that integrates different technological aspects of our everyday social life, in which smart homes, electronic banking and healthcare, smart cities, smart cars or smart mobility are common (Caputo et al., 2021).

3.1.1. Digitalisation in manufacturing

Digitalisation in manufacturing brings new opportunities for the impetus of the Industry 4.0 boom on a global level. New Industry 4.0 approaches and digital transformation have been accelerators of change for different industrial areas. As a result of Industry 4.0, virtualisation, modularisation or optimisation of processes can be approached at the production but also at the technical level. The aim is to be as flexible as possible and to support personalisation in the production sphere. Using digital platforms, it is possible to collaborate more easily, thereby achieving profitability and a sustainable market position.

3.1.2. Digitisation at logistics level

In the wake of automation in production, we can talk about the long-term sustainability of processes. Logistics is a marked problem for which digitalisation opens up new possibilities and the introduction of simple processes. The digitalisation of logistics responds to ever-increasing demands and requirements but also to a dynamically changing market environment. There is no doubt that the institutional view of digitalisation defines it as a socially constructed process in which key actors achieve convergence on the logic of digitalisation. The rise of digitisation at the logistics level can be linked to the emergence of the global crisis caused by the COVID-19 infectious disease, caused by the SARS-CoV-2 coronavirus. Digitisation brings new opportunities and scope for finding new logistics methods. A prerequisite for digitisation at logistics level is a well-founded IT structure, the ability to link different mechanisms and also their compatibility. An example for the digitalisation of logistics is, for example, the creation of applications that contain various functionalities - from the calculation of the shipping price, detailed tracking of the individual steps from the receipt of the order to the delivery of the goods to the customer. QR codes are also a significant area of digital logistics, simplifying both the ordering process and the actual storage and orientation in warehouses. Digitisation in logistics has an irreplaceable role to play.

3.1.3. Digitising supply chains

The emergence of new businesses creates a strong competitive environment and pressure on businesses. The industry has globalised and there is increasing international market penetration. As a result of globalisation and the development of e-commerce, emerging opportunities for growth can be observed. The fact that customers are increasingly searching for and buying goods online and moving away from traditional shopping in brick-and-mortar stores represents an opportunity for the digitisation of supply chains. According to Agrawal and Narain, the essence of digitalisation of supply chains can be defined as the processing of many processes, and at the same time helping supply partners, by interacting with each other using digital platforms (Agrawal, Narain, 2018).

3.1.4. The concept of eco-digitalisation

In addition to the above, it is also extremely important to define the ecological framework of digitalisation. Technological advancements provide a number of incentives for addressing ecological issues, which are a frequently inflected issue of various debates in the contemporary world. As a result of the emergence of ecological digitisation, we can state that technology is benefiting our planet. Joerß, Hoffmann, Mai, and Akbar state that eco-digitalisation represents methods of interaction of digital technologies that have a positive impact on the further business direction of business entities, but their beneficial impact can also be observed on the level of climate preservation and natural resource conservation (Joerß, Hoffmann, Mai, and Akbar, 2021). Examples of eco-digitalisation can be the already echoed big data or IoT, IoS, cloud computing and others. The essence of the concept (as also e.g. the name big data implies) is the storage of large amounts of data in data centres, which however can be ecologically destructive. The excessive and uncontrollable growth of this data also appears to be a problem. All of these situations present a problem and at the same time provide incentives for the introduction of green digitisation.

3.2. Opportunities for applying digitisation in Industry 4.0

Digitalization presents incentives for increasing the performance of business entities, improving their productivity and contributing to the overall growth of the entity. The expansion of digitalization is crucial for the balanced establishment of competition in various business segments. Systems thinking as well as digital transformation has revolutionized the design industry and process engineering operations, as a result of which economic benefits can be contemplated. It is also important to note that Industry 4.0 is not just a revolution but also an evolution. The integrated focus and advanced automation or robotics of systems, the use of data analytics, machine learning, artificial intelligence as well as other virtual mechanisms represent the interconnectedness between the human factor and technology. In the 21st century, interaction is the impetus for societal change and the emergence of new technological aspects.

The main Industry 4.0 sectors where we are seeing the development of digitalisation include, at a global level, the defence and security industry, the chemical and pharmaceutical industry, the automotive industry, the electronics industry, the construction industry, the building and construction industry, the transport industry, as well as the agricultural industry and the printing and paper industry. However, in the context of increasing digitisation, it is also necessary to talk about its energy intensity. The concentration of the use of automated processes should help to reduce the decline in labour productivity. Digital technology has the potential to improve the quality of work, and can be described as one of the most dynamically developing areas in the world today. However, as we have already outlined, it also poses threats, including rising unemployment rates. The industrial cycle of Industry 4.0 affects the whole of society. The problem of implementing digitalisation in different business entities is the attitude of top management who do not consider the implementation of a digital approach to be beneficial. This view usually arises due to a lack of awareness of the opportunities of digitalisation. There are three key areas that can be examined in the context of digitalisation in the automotive industry - connecting the traveller, autonomous vehicles and enterprise/ecosystem digitalisation. These areas are driving value change across the industry. Digitalisation in the automotive industry has the potential to create significant value for the industry and society.

3.2.1. Digitalisation of the defence and security industry

The rise of digital platforms is significantly empowering the military, enabling increased continuity of operations and taking the armed and security forces to a new level of combat readiness, which is essential in the industry. However, with the aforementioned digital technologies such as cloud computing, big data or IoT or AI, there is scope for data loss and theft, which can have a devastating impact on the defence machinery of states. According to Frost, an analyst firm that has been researching digitisation in defense mechanisms, it is important for a successful future of digitisation in the defence industry:

- Providing turnkey digital solutions (the goal is security and rapid implementation of solutions),
- adoption of the concept of the outsourcing business model,

- expanding and building partnerships and creating mutually beneficial agreements,
- continuing to invest in traditional warfighting platforms (Frost, 2019).

3.2.2. Digitalization of the chemical industry

The digital transformation in the chemical manufacturing industry continues to progress. In particular, this can include advances in networks and sensors, data availability and processing, engineering and materials technologies, which have significant potential for building efficient productivity at the chemical industry level. It is important to note that the presence of these dimensions is necessary to achieve consensus in the digital domain:

- User experience (customer analysis for the development of trendiness and digitalization of pharmaceutical companies),
- cognitive tools (using AI it is possible to improve the skills of the workforce using cognitive tools or robotic process automation,
- performance and reliability (by implementing advanced digital technologies, higher performance and more reliable customer perception can be achieved),
- ecosystems (collaboration is an indispensable part, aiming to highlight new forecasts, as a result of which the delivery system can be better managed and new products can be commercialised).

3.2.3. Digitisation of the automotive industry

Europe is one of the strongest drivers of the automotive industry, which is also reflected in the process of digitisation. According to the latest statistics from Statista, Germany is the largest producer of cars in Europe, with 3.5 million cars produced in 2020, which may be a result of the progress in digitising production. Digitalisation in automotive manufacturing is primarily focused on improving internal and inter-company management by applying horizontal integration of the value chain supported by various IT solutions. (According to the World Economic Forum, digitalisation has the potential to change the way transport is currently conducted and to create significant value for the industry and society as a whole.

3.2.4. Digitisation of the construction industry

According to Eurostav, the construction industry is one of the slowest industries to adapt to new technological challenges and applies new materials or equipment only very slowly (Eurostav, 2021). This results in prolonging innovative construction processes, which is costly and inefficient. In several publications, we have come across the claim that digitalisation presents many opportunities for the construction industry, but at least for now it is not sufficiently implemented in the sector. As a consequence of the above, we believe that digitalization in the construction industry would make the production, logistics but also communication framework more efficient.

3.2.5. Digitisation at transport industry level

Digitalization is an important factor for maintaining a reliable system in the transport industry. The logistics industry gains more vision if we talk about the mass adoption of smart and connected digital technologies, applications (e.g. cloud, machine learning..) and the improvement of vertical and at the same time horizontal collaboration between supply chain partners (Kayikci, 2018).

3.2.6. Digitalisation in agriculture

At the agricultural level, the term precision farming is often bandied about, which is expected to save farmers up to 30% of their current expenses as a result of its proper implementation. It is the involvement of modern technologies and the digitalization of several areas that can reduce input and fuel costs (sprays, fertilizers, financial evaluation of employees, etc.). Digitisation in agriculture should also ensure a reduction in the carbon footprint. In practice, however, the sector is often faced with the problem of a lack of financial capacity to cover the high costs that the implementation of new digital practices entails.

3.2.7. Digitisation of the paper and printing industry

At the outset of the issue of digitisation in the paper and paperboard industry, the question that came to mind was „can paper survive digitisation?" The paper industry, in combination with the printing industry, can be classified as one of the industries that bring potential in the circular economy. However, digitisation in this area can be seen in the change in the original concept of production by replacing it with renewable resources that improve the environment. It can also be predicted that there will be a change in the pulp and paper industry to modern lignocellulosic biorefineries that will create new products with higher added value. Thus, in terms of digitisation, the paper and printing industry can be defined in terms of the introduction of process automation, the digitisation of various task operations or of the robotization of production.

Concluding the analysis of the different industrial sectors in their digitisation approach, we can point out the implemented digitisation models in each of the described sectors. The aim of digitisation is to increase the performance of industries, their innovation and their competitiveness.

3.3. Industry 4.0 and the Lean method

The approaches of current literature sources quantify two main visions that link lean management and Industry 4.0, which define that lean management is a necessary foundation for the existence of Industry 4.0, and at the same time Industry 4.0 improves the efficiency of lean.

Standardized processes, elimination of waste materials, as well as continuous progress in delivering quality value to customers are the foundation of Industry 4.0 (Mayr et al., 2018). A lean approach enables the efficient and cost-effective use of technology offered by Industry 4.0. The correlation of Industry 4.0 and lean management tools signifies the interconnection of the physical and cyber worlds through state-of-the-art technologies.

The five-step model, which we visualize using Figure 3, interprets the sequence of steps underlying the Lean management principle. It consists of the following parts:

- Value definition - the key is the correct definition of value and value represents what the customer is willing to pay for.
- Value stream mapping - in the second step, the key is the identification and mapping of the value stream, which consists of identifying all the activities that contribute to value creation.
- Value stream creation - the key is to remove the so-called waste from the value stream. This step will ensure that the flow of other values is smooth, without activities that could disrupt or affect them in a negative way.
- Securing the pull - the goal is to reduce the inventory and work in progress of the WIP process and ensure the availability of resources and information needed for a smooth flow of work.
- Strive for a perfect outcome - using the previous steps, failure should be eliminated as much as possible and processes should be continuously improved as part of the industries organizational culture.

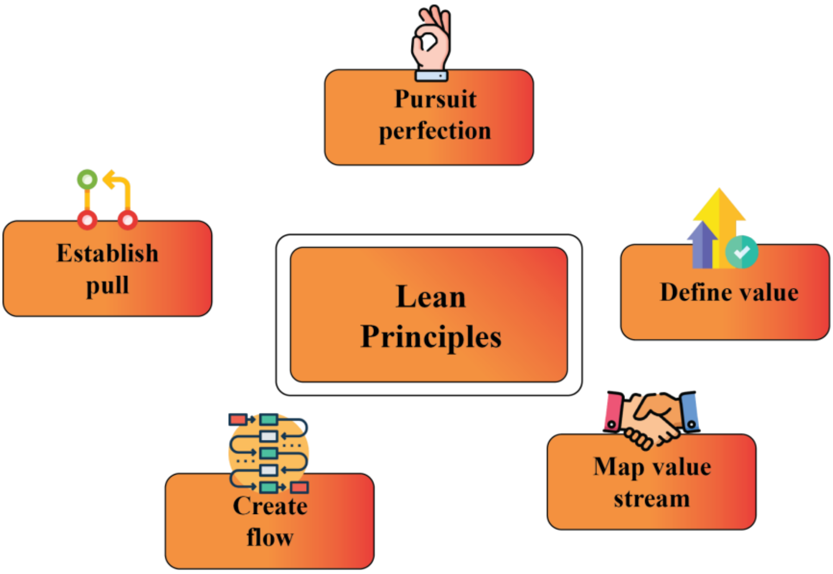

Figure 3. Five key Lean Principles

The essence of Lean management is to reduce and minimize waste in the production system that does not add value to the organization while maximizing productivity within the system. Although it seems that the concept of Industry 4.0 could replace the Lean philosophy, it is important to define that both concepts are interoperable and their synergy can help in solving problems arising at the business environment level.

3.4. Examples of Industry 4.0 digitalisation best practices

The development of Industry 4.0 has brought with it a number of changes to which different industries have had to adapt. The digital economy and the increasing convergence of the exponential technology boom is building room for improvements to current business models and strategies, which is true for various industries. In the following section, we describe selected examples of the application of Industry 4.0 digitalisation in a practical context. Among the interesting examples of digitalization of Industry 4.0 can be included selected best practices, which we present in Table 3.

Table 3. Best practices digitization Industry 4.0

Industry 4.0 voucher	Kickstart Digitalization
House of digitalization	Regional innovative node
Use of Open Data	Kickstart digitalization method
Small-scale incentives for smes	Hackathons as cooperation platform
Business and share services centre	E-tourism info portal
5G step-out centre	Digital innovation hub

3.4.1. Industry 4.0 voucher

An example of the implementation of Industry 4.0 vouchers is Portugal. Industry 4.0 vouchers aim at pursuing a proprietary technological strategy to improve the competitiveness of a company. The essence of this practical example within Industry 4.0 is digital transformation through the adoption of technologies that enable disruptive changes in business models at SME levels. The vouchers have a unit value of €7,500 and should help more than 1,500 companies (Interregeurope, 2021).

3.4.2. House of digitalization

This is an initiative that was created within the Lower Austrian ecosystem because of digital transformation. The initiative includes an interactive platform (Available at: www.virtuelleshaus.at), which can be described as a local example of good practice in the field of digitalization of Industry 4.0. It enables access to information, training, infrastructure and mutual cooperation between the different partners. It also offers matchmaking and crowdfunding campaigns that provide funding for open innovation.

3.4.3. Use of Open Data

Among the drivers of the use of open data platforms, we can certainly include the United Kingdom. Businesses participating in this platform can test their new products and business models instantly using a rapid feedback system. This platform offers businesses, especially SMEs, the space to develop innovation and improve their market position. In practice, the open data platform is proving to offer potential for different industries within different regions, an example of which is open data on health and transportation in Canada in 2017. This data helped researchers discover and describe the connections between road/highway conditions and the onset of neurological diseases, such as Alzheimer's disease or dementia.

3.4.4. Small-scale incentives for SMEs

The concept originated in Slovenia. The main purpose of the voucher system is to provide financial assistance to SMEs by co-financing services in different areas. However, the amount of financial support is limited. A maximum of 60 % of eligible expenditure can be co-financed per voucher, with a maximum voucher value of € 10 000. However, obtaining financial support is subject to a number of pre-specified requirements. This platform is also suitable for different countries within different industries thanks to its digitalisation, as the content of the vouchers can be adapted to the pre-specified conditions and needs of the country or region (Interregeurope, 2021).

3.4.5. Business and share services centre

An example of good practice for this digital platform is again Portugal, with its headquarters in Fundão. The business centre in Fundão won the 2018 Regio Stars award in the category „Supporting Smart Industry“. This project aims to bridge the gap between demographic and economic decline in the provision of IT services and infrastructural competences to businesses and start-ups.

3.4.6. 5G step-out centre

The centre, located in Westcott, United Kingdom, enables the rapid deployment of proof-of-concept prototypes as well as quality, safety, and reliability assessment projects in the various network areas involved within the 5G domain. While this example of best practices cannot be intuitively embedded within systems deployed in different regions, one of the options for supporting and strengthening clusters is the use of dedicated innovation centres that have been created to meet the needs of enterprises.

3.4.7. Kickstart Digitisation

This is a method that is part of the Swedish Smart Industry Strategy. Kickstart is the result of the largest national effort and cooperation, resulting in the promotion of digital skills and the use of digital technologies among SMEs in the manufacturing sector in Sweden. The aim of this method is to educate in the use of digital technologies among SMEs in the manufacturing sector with the intention of digitising businesses towards Industry 4.0.

3.4.8. Regional innovation node

The concept of regional innovation nodes has proven to be a tool for coordinating and facilitating innovation and industrial transformation in a regional setting. The aim of this platform is to coordinate stakeholders and facilitate the development of innovation with the intention of driving regional development and the transformation of the business of the future. The main stakeholders include RISE Research Institutes of Sweden, the Community of Hudiksvall and Gävleborg Region. The stakeholders have formed the node as an association. A member of RISE is in charge of the operation of the node. By this setup the node receives core funding that can also be used in public projects. We introduce this platform because many regions in Europe are struggling with scaling up innovation and managing regional development in large but sparsely populated regions.

3.4.9. Hackathons as cooperation platforms

Hackathon is now a well-known platform that brings industry and IT together. The aim is to cooperate, collaborate, create new products, innovations and propose solutions to different problem situations in a short period of time. To define best practices, we present one of the most successful hackathons, which is called X-industry. The concept of this hackathon was to promote business innovation by companies from different fields. The essence of the hackathon is experimenting, discussing possible solutions and looking for digital solutions to eliminate their business shortcomings/threats. With the rapid development of technology and digitalization, there is an ever-increasing demand for divergent solutions.

3.4.10. E-tourism info portal

Tourism is a key area for Industry 4.0. In terms of a practical definition of Industry 4.0, we can cite the example of the development of e-tourism through digital guidance and digital localisation of the Transylvania Info Portal, which is considered the best methodology in the context of the INNO INDUSTRY project, as the cluster supports the development of a service within the tourism sector and this contributes to the promotion of the digital transformation. E-tourism describes the digitalisation of processes and value chains with the aim of optimisation and efficiency. Thus, at the level of digitisation, we are talking about areas such as: electronic information, electronic reservations (hotels, restaurants, means of transport, etc.) or electronic payments. The information published by the Transylvanian Information Portal mechanism includes QR codes, GPS coordinates, digital guides and smartphone apps. This information is not only important for their end-users but, due to its specificity, also for travel agencies in building quality service packages.

3.4.11. Digital innovation hub

DIH is the contact point in Slovenia for information and support regarding the digital transformation of companies. The aim is to build digital competences, innovation models and processes that support their digital transformation and increase their competitive advantages that come from the digital technology environment. The Digital Innovation Hub in Slovenia focuses on supporting industries that can apply digital transformation approaches, as a result of which they can subsequently benefit from them and ensure increased competitiveness. This method works by integrating already known knowledge and services and focuses on building new services, increasing their promotion and awareness, and co-financing digitisation projects in different enterprises.

4. CONCLUSION

In the present chapter of the scientific monograph, we provide summaries of Industry 4.0 issues in the context of the digitalization phenomenon. The introductory issues of the chapter consist of historical milestones that reflect the basic elements, parts and principles of the Industry 4.0 concept. In order to thoroughly clarify the issue for the reader, we focus on the field and process of digitalization in several industries and in the context of the integration of the two areas under study. An important part of the chapter is also the definition and outline of the categories of the different Industry 4.0 tools. Due to frequent misrepresentation of information in the chapter, we delineate the differences between digization and digitization. We complement the examined issues of digitization and Industry 4.0 with selected examples of the implementation of digitization in practical terms.

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THE IMPACT OF THE FOURTH INDUSTRIAL REVOLUTION ON THE ECONOMIC EFFICIENCY AND GROWTH

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Abstract

In 2016 Klaus Schwab wrote, that the Fourth Industrial Revolution has the potential to raise global income levels and improve the quality of life for populations around the world. His opinion has been confirmed for many years. As for preceding industrial revolutions, also this time the question has been asked if the ongoing changes only improve the existing economic processes or do they define new economic principles. Regardless of the outcomes of this debate, the Fourth Industrial Revolution is expected to bring another wave of economic efficiency and growth. The subject of this article is the identification of the basic relationships between the level of digitisation of the economy and selected economic indicators. The study was preceded by the creation of a database of 112 countries (split into developing countries and developed countries) containing several economic indicators related to the efficiency and growth of individual economies. For both groups of countries, the statistical relationship between the synthetic Euler Hermes Enabling Digitalisation Index (EDI) and economic indicators has been examined. The results presented, on the one hand, confirm the majority of opinions on the impact of digitisation on economic development. On the other hand, they open up the field for discussion on the other, also qualitative consequences of the ongoing changes.
Keywords: *Economic efficiency, Economic growth, Digitisation*

1. INTRODUCTION

The development of the market economy has for decades been associated with the constant search for new paths of growth. New economic laws and new management principles are constantly supported by technological progress, which in successive editions of technological revolutions contributed to more effective use of limited economic resources.

Klaus Schwab was the person who labelled today`s advances as the Fourth Industrial Revolution. In a 2016 article (Schwab, 2016), Schwab wrote that “like the revolutions that preceded it, the Fourth Industrial Revolution has the potential to raise global income levels and improve the quality of life for populations around the world." In the same article he continued: “In the future, technological innovation will also lead to a supply-side miracle, with long-term gains in efficiency and productivity. Transportation and communication costs will drop, logistics and global supply chains will become more effective, and the cost of trade will diminish, all of which will open new markets and drive economic growth”.

On the other hand, however, Schwab also suggested the revolution could lead to greater inequality, “particularly in its potential to disrupt labour markets.” Furthermore, he warned, that the job market may become increasingly segregated into “low-skill/low-pay” and “high-skill/high-pay” roles, which could escalate social tension.

The changes introduced by the Fourth Industrial Revolution should help overcome further barriers to development that is to serve humanity. However, it should be remembered that changes induced by the Fourth Industrial Revolution are so profound that, from the perspective of human history, “there has never been a time of greater promise or potential peril”.

The purpose of this article is to make a preliminary diagnosis of the impact that digitisation has on the basic economic parameters of individual countries. These parameters directly or indirectly illustrate

their potential for economic growth and overall efficiency of the economy.
The following chapters present the concepts of economic efficiency and economic growth. The channels, the fourth industrial revolution's technologies influence on the economic growth were further characterised. The key part of the study is a preliminary diagnosis of statistical dependencies between the level of digitisation and selected economic indicators.

2. THEORETICAL ASPECTS OF ECONOMIC EFFICIENCY

All societies strive to shape such conditions for the economy that lead to a better quality of life. To gain that goal, economists and politicians pursue economic development, economic growth, and economic efficiency. When referring to improvements to a country's economy, all these terms are often used interchangeably.
Economic growth is a simple concept with a specific measurement of the increase in output by a given economy. If a country’s product output capacity grows over the year, there will be economic growth. Long-term growth can lead to economic development, which leads to benefits such as increased employment rates and national income. These benefits in economic development lead to an increase in the standard of living for citizens of the country. Increased economic development can help to reduce the rate of poverty in a country. Economic growth also provides additional tax income which is used for government spending.
The overall scope of economic development is far broader than that of economic growth. Instead of measuring only quantitative results, most economic development plans yield qualitative results. Most of them revolve around improving the quality of life. Economic development can be measured on a scale known as the Human Development Index (HDI) (Human Development Reports, 2021), though other forms of measurement are used as well. These qualitative results are measured to gauge the success or failure of certain economic development

programs, which will affect the potential for conditions that will eventually lead to economic growth.
As the concepts of economic growth and development are linked, they require one another to both remain effective. Economic development is often a means to accomplishing economic growth but on the other hand, both are dependent on economic efficiency which is about society making optimal use of scarce resources. There are several meanings of efficiency, but when it comes to a market economy, all of them refer to how well a market system allocates scarce resources to satisfy consumers. A perfect market mechanism is good at allocating these inputs, but there are many occasions when the market can fail.
Regarding the objective of the article, a distinction between short term and long term economic growth is very important. Short term economic growth is cyclical. It changes both due to changes in aggregated demand and due to changes in short-run aggregated supply (in particular wages costs and resources costs). Short economic growth is also susceptible to short term external shocks affecting both - demand and supply, and to short term policy changes (e.g. changes in interest rates set by National Bank). Inversely, the long-run economic growth is essentially "supply-side" driven by the country's productivity performance, by cutting edge technologies, by the strength of their business cultures, by changes in the size of the active labour force and also by the rate of capital investments. Ultimately, it is the long term economic growth that should be analysed as a category most dependent on the use of new technologies. Moreover, it is the long-term economic growth that synthetically takes into account the aspects of both, economic development and economic efficiency of the economy.

3. SELECTED MEASURES OF MACROECONOMIC EFFICIENCY AND GROWTH

When measuring economic growth at the national level, we most often follow the real Gross Domestic Product (GDP). When both aggregate demand and aggregate supply increase, so does the market value of the goods and services. While the increase in aggregate supply and demand is the primary driver, other factors drive economic growth as well. While this sounds like a simple explanation, getting the actual growth to occur can be quite challenging depending on the number of circumstances and factors. It often comes with the development of new technologies or industries. It can also be sparked by initiatives aimed at developing the economy to allow growth.

Measures of the economy's efficiency, in turn, refer to the relationship between the measure of economic effects and the efforts made. The beginning of work on defining the measure of the final product of the economy can be considered to be 1758 when François Quesnay developed the so-called "economic board" (Tableau Economique), the first in history of economic simple reproduction scheme and the prototype of national accounts. It enabled the diagnosis of the economic situation which is also the task of national accounts today (Zieńkowski, 2007). Quesnay's work has brought a new look at the concept of „productive work" as giving an „additional product". Today, the compilation of the gross domestic product accounts consists of an independent compilation of the GDP based on expenditure and production, which are then subject to balancing, using additional income information. The expenditure approach includes total consumption, investments, government spending and foreign trade turnover. Due to the availability of the data, the production approach is considered to be a more reliable one. It requires a calculation of global production, intermediate consumption, gross value added, product taxes fewer subsidies on products (Zieliński, 2019).

When determining the efficiency of the economy, GDP can be related to various categories of inputs. Depending on the purpose of the analysis, these may include, in particular the size of the workforce and the total energy consumption. The efficiency of the economy can also be measured indirectly, based on indicators that should affect the efficiency of the economy in the strict sense. These include, in

particular: the unemployment rate, the schooling rate, the use of renewable energy sources, the Gini inequality index and others.
The above-mentioned measures will be used in chapter 7 of the study to identify the correlation between the degree of digitisation and the efficiency and growth of the economy.

4. KEY LINES OF TRANSFORMATION TOWARD INFORMATION ECONOMY

The decades-long technological progress has been changing the principles of the functioning of societies, states and, above all, economies. The history of progress has been divided into 4 successive phases.
The first industrial revolutions were based mainly on the improvement of the physical tools of production, the development of energy sources and means of transport, which allowed to increase the efficiency of human work. The implementation of the new technologies took a long time, spanning 1760-1840 in Europe and the United States. It had an impact mostly on the textile industry, which was the first to adopt such changes, as well as the iron industry, agriculture and mining. The Second Industrial Revolution encompassing the period between 1871 and 1914, resulted from the installations of the widespread railroad and telegraph networks, which allowed for faster transfer of people and ideas. Widespread electrification allowed for factories to modernize production lines. Both revolutions resulted in great economic growth, with a tremendous increase in productivity, nevertheless also caused a surge in unemployment (many factory workers were replaced by machines) and enormous usage of energy and natural resources.
Successive industrial revolutions (third and fourth) were triggered by the development of information technologies. The Third Industrial Revolution, also known as the Digital Revolution, started in the late 20th century, in the aftermath of the industrialisation slowdown. It brought the rise of electronics, telecommunications and computers. The third industrial revolution opened the doors to space expeditions,

research, and biotechnology through the new technologies (Institute of Entrepreneurship Development, 2019). With the Third Industrial Revolution, the importance of those branches of the economy that naturally rely on information processing, such as finance, telecommunications and entertainment, have spectacularly increased. For the same reason, the role of services increased. It gradually replaced production, which was still more immersed in the industrial age. Even traditional sectors of the economy have been wrapped in dense information tissue, gradually increasing the number of information flows.

The Fourth Industrial Revolution pushed deindustrialisation even further. It conceptualises rapid change to technology, industries, and societal patterns and processes in the 21st century due to increasing interconnectivity and smart automation. This phase of industrial change is marked by the joining of technologies like big data processing, artificial intelligence or advanced robotics that all blur the lines between the physical, digital, and biological worlds. The global production and supply networks are being changed by ongoing automation of traditional manufacturing and industrial practices, using modern smart technology, large-scale machine-to-machine communication (M2M), and the internet of things (IoT). It also represents a social, political, and economic shift from the digital age of the late 1990s to an era of embedded connectivity distinguished by ubiquitous technological innovations.

In the wake of The Fourth Industrial Revolution, information and data gained the status of the fourth (next to land, labour, and capital) and major factor of production. It can be said with some overestimation that data have become for the modern economy what coal and steel for the industrial economy, and crude oil for the 20th century (Śledziewska & Włoch, 2020).

The ability to derive value from data increasingly determines competitive position in the marketplace, changing the way businesses and the economy operate. Datafication has significant social and economic consequences. Human life is affected in many respects:

social relations, consumer behaviour, production processes, and political commitment. Datafication also creates the ground for new business models developed by technology companies and platforms. It is estimated (Śledziewska & Włoch, 2020) that 84% of the market value of companies on the S&P 500 list is based on intangible resources, including the use of data or software. Companies such as Google, Amazon and Facebook also owe their unprecedented market success to the possibility of using their users' data, including to optimize the offer or predict consumer behaviour (van Dijck, 2014).

5. THE IMPACT OF THE FOURTH INDUSTRIAL REVOLUTION'S TECHNOLOGIES ON THE ECONOMIC GROWTH

It is widely accepted that technology is the key driver of the economic growth of countries, regions and cities. Technological progress allows for the more efficient production of more and better goods and services. Nonetheless, the mechanisms through which technology is developed, adopted and used in production are complex. They involve many areas of economic and social policy (Hausmann & Domínguez). Digital technology includes the composition of knowledge and tools that facilitate the application of economic resources as a way to produce goods and services more efficiently, more innovatively and faster. Technological progress is essential to economic growth and development, and the more advanced the technology available, the more quickly the economy can grow. Technology impacts economic development in many ways (Figure 1).

Figure 1. The ways technology impacts economic development
Source: https://hardeebusiness.com/

Digital technology can save the time it takes to produce a good or deliver a service, contributing to the overall profits of a business. It can contribute to the efficiency of a business's output rate, allowing for larger quantities of products to be moved or of services to be rendered based on the same resources. Technological improvements in physical assets and capital will greatly impact economic growth. Creating better factories or machinery will end up increasing a business's productivity, more than adding physical labour. The increased productivity will increase output as well as lower the business' overall cost. Technology leads to an increase in the division of labour and the specialisation of jobs within a business. It improves the efficiency with which a business can run.

Any discovery of more natural resources will provide a boost in economic growth. However, scarce natural resources should be balanced to avoid the risk of depleting them entirely. It is expected, that involving innovation should have a huge effect on the ability of businesses and governments to reduce the demand for natural resources and use them in the most effective ways possible to benefit both the business and the economy.

With the increased efficiency of labour alongside and with the permanently improving state of technology, businesses can increase total output, which entails higher profits and greater economic development. Better technology has always led to further research into nearly every sector of business and science. Improvements and developments in technology can have tremendous impacts on businesses. Investing in new technology that speeds up processes or makes them easier can provide an increase in output without bringing on more labour, leading to an increase in both growth and development. Relevant education is the primary driver of the economy compared to research. Its adaptation to the challenges of the digital economy is today a basic condition for economic growth. Universal networking has undoubtedly become the dominant factor in the economic growth of economies. The ubiquitous Internet has become a modern platform for global trade and information exchange.

6. SELECTED MEASURES OF DIGITISATION

Studying the impact of digitisation on the efficiency and growth of economies requires the use of a synthetic measure of the digitisation of the economy. As the term "digitisation" is not fully unambiguous (for example, often used interchangeably with digitalisation), its measures are even more ambiguous. The most basic of them focus on information technology saturation, suggesting a potential for more widespread and effective use. The description of digitisation is most often based on simple indicators measuring one selected aspect, or they are synthetic, including several simple indicators.

An example of simple measures of digitisation of societies is rankings and ratings available on the Internet World Stats (Available at: https://www.internetworldstats.com). Internet World Stats is an International website that features up to date World Internet Users, Population Statistics, Facebook Stats and Internet Market Research Data, for over 250 individual countries and world regions. Internet World Stats is a useful source for country and regional statistics, international online market research, the latest Internet information, world Internet penetration data, world population statistics, telecommunications information reports, and Facebook Stats by country (Figure 2).

WORLD INTERNET USAGE AND POPULATION STATISTICS 2021 Year-Q1 Estimates						
World Regions	Population (2021 Est.)	Population % of World	Internet Users 31 Mar 2021	Penetration Rate (% Pop.)	Growth 2000-2021	Internet World %
Asia	4,327,333,821	54.9 %	2,762,187,516	63.8 %	2,316.5 %	53.4 %
Europe	835,817,920	10.6 %	736,995,638	88.2 %	601,3 %	14.3 %
Africa	1,373,486,514	17.4 %	594,008,009	43.2 %	13,058 %	11.5 %
Latin America / Carib.	659,743,522	8.4 %	498,437,116	75.6 %	2,658.5 %	9.6 %
North America	370,322,393	4.7 %	347,916,627	93.9 %	221.9 %	6.7 %
Middle East	265,587,661	3.4 %	198,850,130	74.9 %	5,953.6 %	3.9 %
Oceania / Australia	43,473,756	0.6 %	30,385,571	69.9 %	298.7 %	0.6 %
WORLD TOTAL	7,875,765,587	100.0 %	5,168,780,607	65.6 %	1,331.9 %	100.0 %

Figure 2. An example of statistics available on the Internet World Stats

Source: https://www.internetworldstats.com/stats.htm

For individual countries, data on the absolute values of Internet users and proportional values of the Internet penetration rate are available, which allows for the creation of a very detailed "Internet map of the world".

The other example of the simple digitisation measures is the robotisation ratio. The most popular robotisation indicator for many years has been "Robot density in the manufacturing industry", developed for many years by the International Federation of Robotics. The IFR was established as a non-profit organisation in 1987. The general purpose of the IFR is to promote research, development, use and international cooperation in the entire field of robotics (Bill, 2021). Robot density in the manufacturing industry index addresses the use of industrial robots in factories around the world (Figure 3).

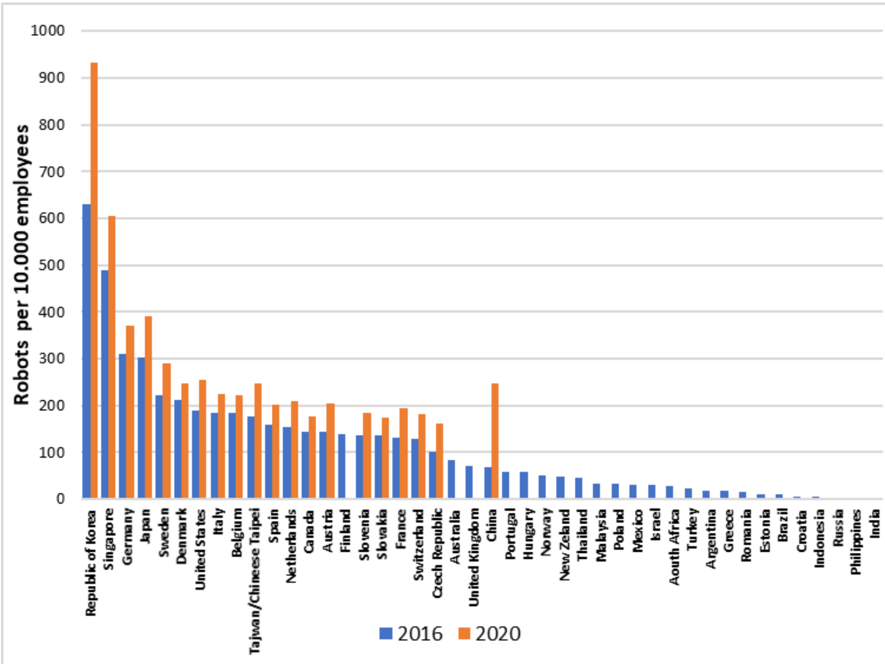

Figure 3. Robot density in the manufacturing industry index
Source: https://ifr.org/

The application of robots in manufacturing industries is particularly valuable for economic growth. Robots have been used for high-volume operations, but as the technology advances and the cost of industrial robots decline, more options and opportunities are opening for medium- and small-sized operations. At the same time, these robots are helping manufacturers address many of the key challenges they face, including tight labour pools, global market competitiveness and safety. In the foreword to the World Robotics 2021 Industrial Robots, Marina Bill, Chairperson IFR Industrial Robot Suppliers Committee writes: “This is the decade where robotics and automation will change the way we work and create a world where people work side-by-side with advanced robots, collaborating on complex tasks, improving the nature of work and helping to advance society. This is the decade when

we will fully harness the power of robotics, to unlock growth in new sectors of the economy and when we make work more rewarding, safer, healthier – and more productive for people" (Bill, 2021).
Composite measures are more complex than simple digitization measures. An example of a synthetic digitisation index could be DESI (Figure 4). The Digital Economy and Society Index (DESI) is a composite index that summarises relevant indicators on Europe's digital performance and tracks the evolution of EU Member States, across five main dimensions: Connectivity, Human Capital, Use of the Internet, Integration of Digital Technology, Digital Public Services (Digital Economy and Society Index, 2021).

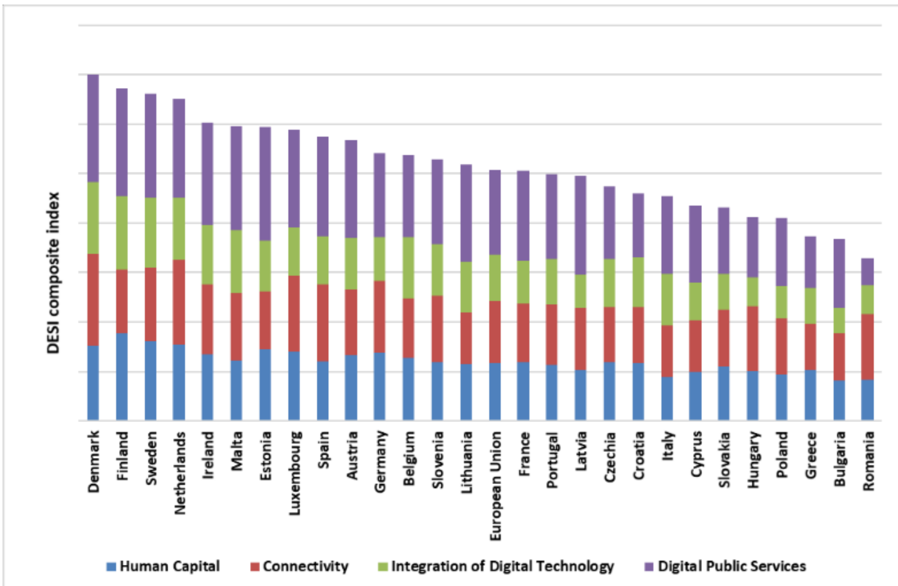

Figure 4. The Digital Economy and Society Index (DESI)
Source: https://digital-agenda-data.eu/

European Commission services selected various indicators, divided into thematic groups, which illustrate some key dimensions of the European information society (Telecom sector, Broadband, Mobile, Internet usage, Internet services, eGovernment, eCommerce, eBusiness, ICT Skills, Research and Development). These indicators allow for a comparison of progress across European countries as well as over time. However, limiting the scope of DESI indicators to European countries only significantly limits their usefulness for comparative study.

An alternate synthetic measure of digitality is The Euler Hermes Enabling Digitalisation Index (EDI) (Measuring Digitality, 2018). It measures the ability of countries to help digital companies thrive and traditional businesses harness the digital dividend. The EDI does not measure digital adoption or digital activity as it was in DESI but rather focuses on the conditions for companies to transform or thrive digitally (a score from 0=worse to 100=best for each category) (Measuring Digitality, 2018) (Figure 5).

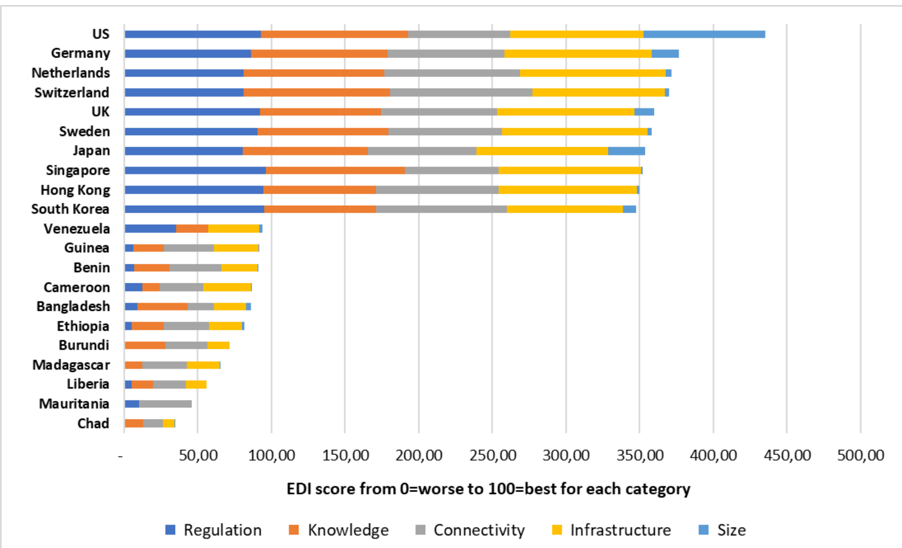

Figure 5. Top 10 and bottom 10 countries in EDI digitalisation ranking
Source: Measuring Digitality (2018)

The EDI score is made of 5 components: Regulation, Knowledge, Connectivity, Infrastructure, and Size which focus on the five strategies pursuing boost of digitisation: 1. Develop proactive digital regulation; 2. Build human capital and digital capabilities; 3. Use pivots (sectors, territories) for stronger connectivity; 4. Bank on smart logistics and 5. Reduce digital inequalities (Measuring Digitality, 2018). As the EDI offers data for a much broader range of countries (not only EU Member States as DESI), it will be used for further analysis.

7. IMPACT OF DIGITISATION ON THE ECONOMIC GROWTH AND EFFICIENCY

7.1. Research assumptions

The main study of the impact of digitisation on economic efficiency and growth was based on the World Bank data and then related to The Euler Hermes Enabling Digitalisation Index (EDI). For the study purpose, two groups of countries have been distinguished, depending on the average value GDP per capita for the period 2010-2020 (Figure 6 and Figure 7).

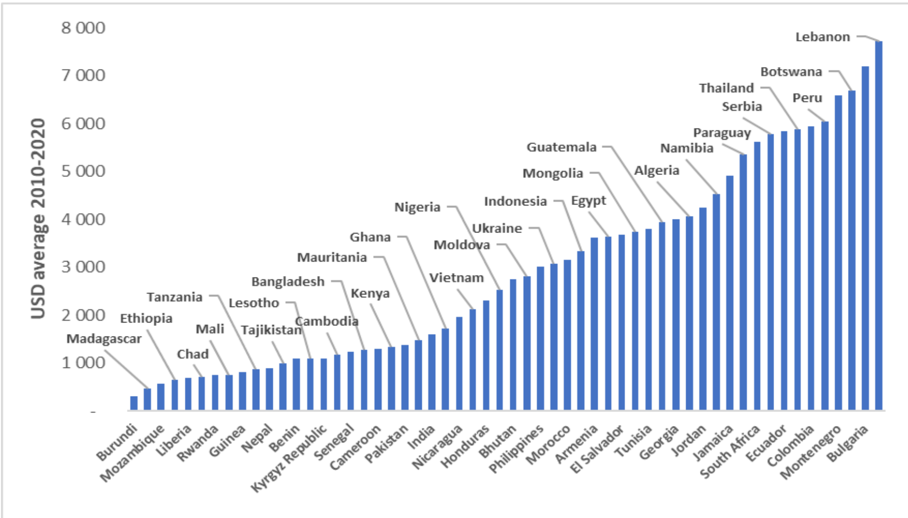

Figure 6. Countries with GPD per capita below 8000 dollars per capita
Source: World Bank (https://data.worldbank.org/)

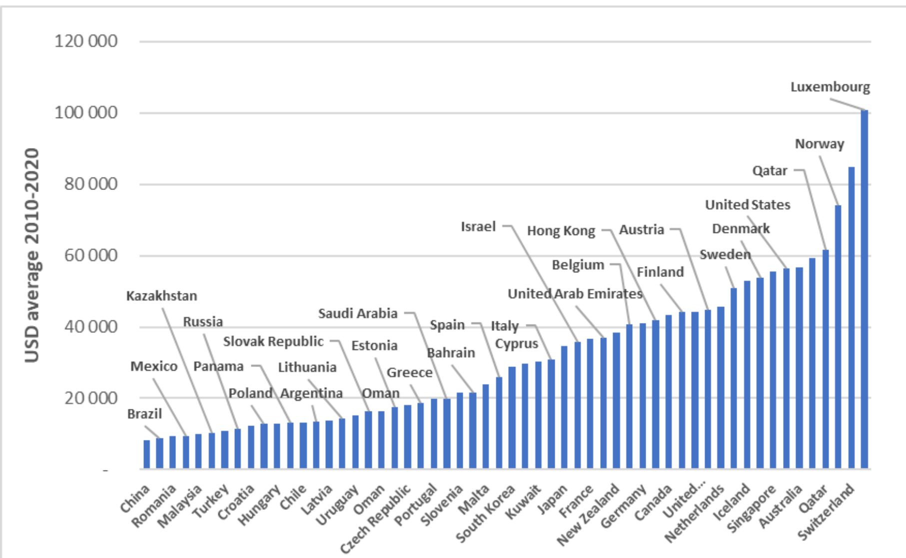

Figure 7. Countries with GPD per capita over 8000 dollars per capita
Source: World Bank (https://data.worldbank.org/)

It could be expected that the results obtained for less developed countries (below 8000) may differ significantly from the highly developed countries (over 8000). For both groups of countries, the statistical relationship between the synthetic EDI digitisation index and socio-economic indicators related to the efficiency and growth potential of individual economies obtained from the World Bank database (Available at: https://data.worldbank.org/) will be examined. The study has been conducted in the following categories:

1. General economic growth,
2. GDP structure – industry vs. services,
3. Employment,
4. Consumption,
5. Equity and salaries,
6. Energy consumption,
7. Environment,
8. Research and development,
9. Education.

Selected detailed indicators have been used for each category.

7.2. General economic growth

As previously discussed, GDP is the basic measure of the economy's efficiency and growth. Due to the significant differentiation in the size of the surveyed countries, GDP per capita has been recognised as the best measure for their comparison (Figure 8).

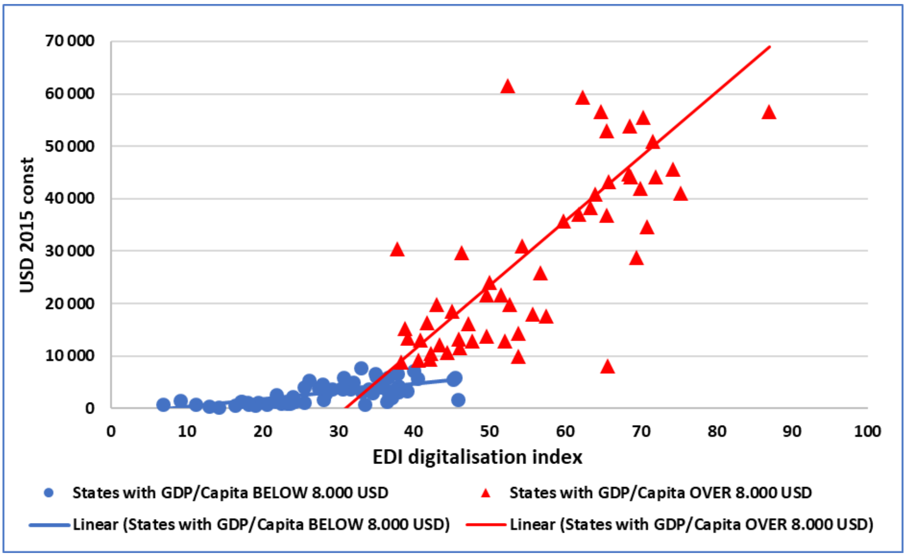

Figure 8. GDP per capita (constant 2015 US$)

The data presented in the chart illustrate two key relationships. First, poorer countries (below 8000) have a low level, while rich countries (over 8000) have a high level of digitisation. Secondly, in the group of poorer countries, the increase in GDP per capita due to the increase in digitisation is much (approx. 8 times) slower than in the group of rich countries.

The level of GDP per Capita in absolute terms is very different for both groups, while the average GDP per Capita growth rate is rather similar. It can even be said that for poorer countries it is higher by about 1% per annum and is more correlated to the digitisation index (Figure 9). While the adopted methodology does not allow for the determination of the cause-effect relationship of the studied quantities, in both of the above relationships it can be expected that it is the digitisation that contributes to the growth of the value and dynamics of GDP per capita.

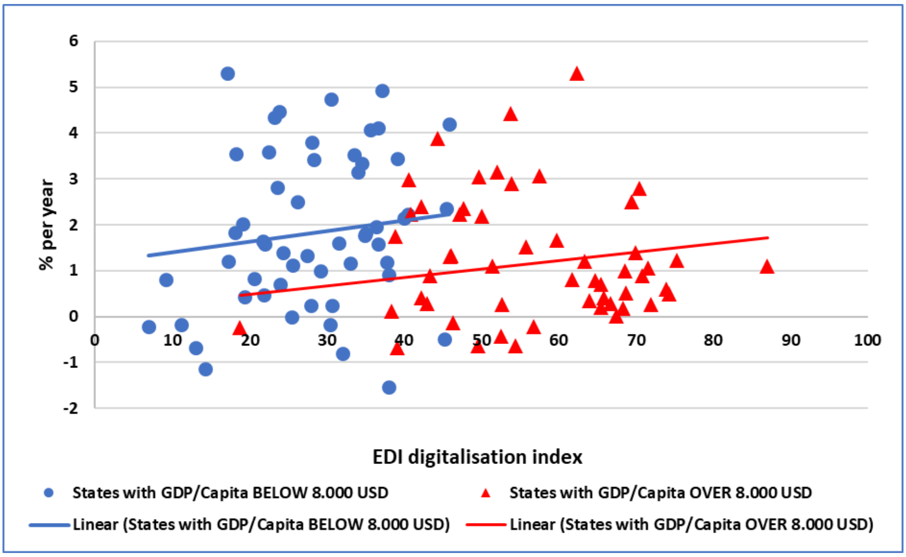

Figure 9. GDP per capita growth

7.3. GDP structure – industry vs. Services

One of the key consequences of the digitisation of economies in all the countries is the change in the structure of GDP. Over the last few decades, the share of services has grown dynamically, reaching the level of 70% of GDP in the most developed countries. At the same time, economies were subject to gradual deindustrialisation entailing a significant reduction in the share of production in GDP.

The share of value-added by services (% GDP) clearly depends on the level of digitisation of the country (Figure 10). For the countries "below 8000" this share is much lower than for the countries "over 8000". At the same time, however, the dependence of the share of services on the level of digitisation is almost identical in both groups.

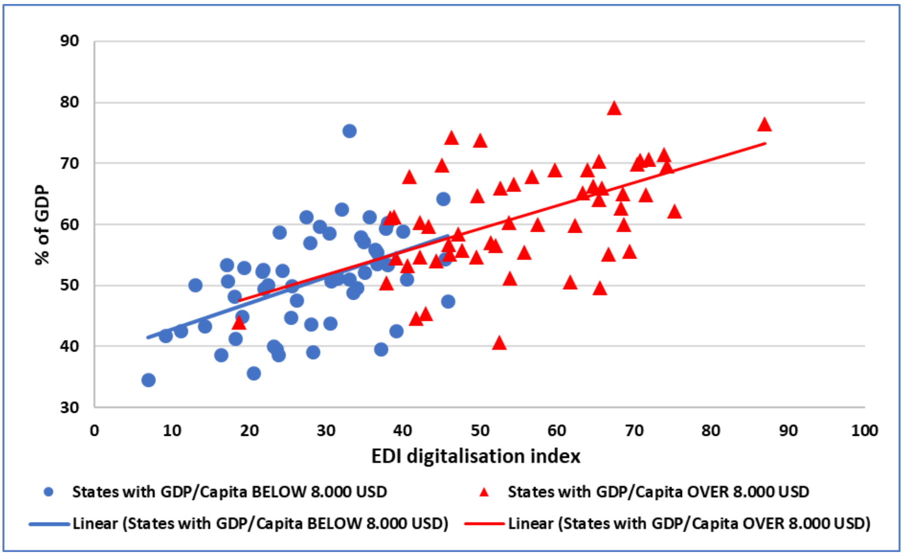

Figure 10. Services (% of GDP), value added

The relationship between the increase in digitisation and value-added by the industry (% of GDP) is different (Figure 11). While for highly developed countries the increase in digitisation is associated with deindustrialisation, developing countries still use the digital economy to foster the industry.

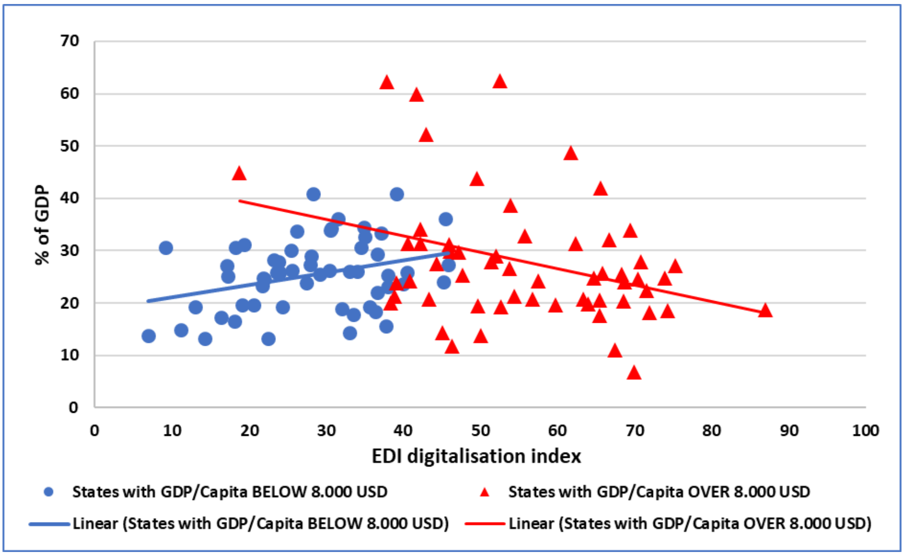

Figure 11. Industry (including construction; % of GDP), value added

It is, therefore, to be expected that developing countries are using the digital potential to replace agriculture with both services and industry.

7.4. Unemployment

Employment is an inevitable condition for sustainable economic growth. There are fears that the progressing automation, digitisation and robotisation of the economy will cause a crowding-out effect, displacing people from the labour market (Ford, 2015). By analysing the relationship between the level of digitisation and the indicator of total unemployment (% of the total labour force), it can be concluded that these fears are relevant mostly at a lower level of digitisation (Figure 12).

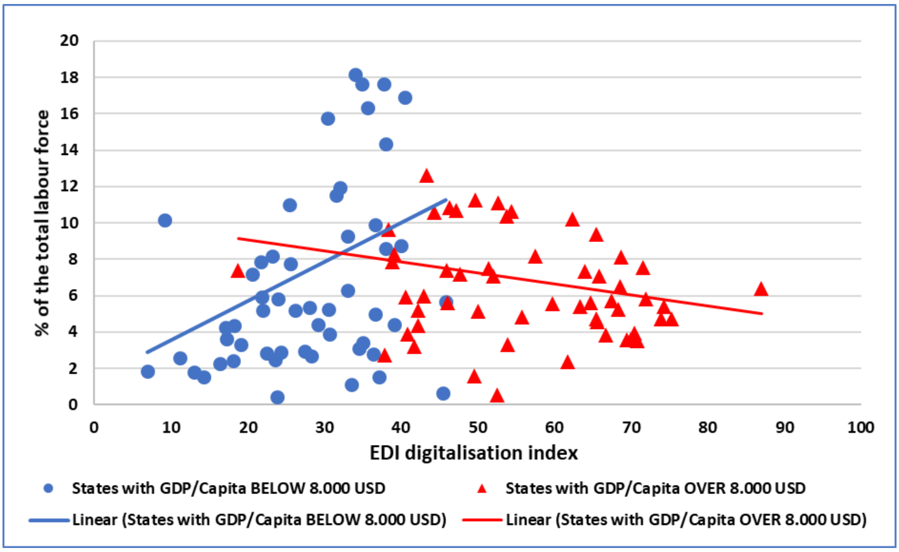

Figure 12. Unemployment (% of total labour force)

In developing countries, the potential of the digital economy is mainly used to catch up with industrialisation. Production automation is therefore associated with an increase in the overall unemployment rate. In developed countries, contrary to the concerns of sceptics, higher levels of digitisation are associated with lower unemployment. It should be assumed that in economies based mainly on services, there is a balanced change in the structure of labour demand, which does not result in a general reduction in employment.

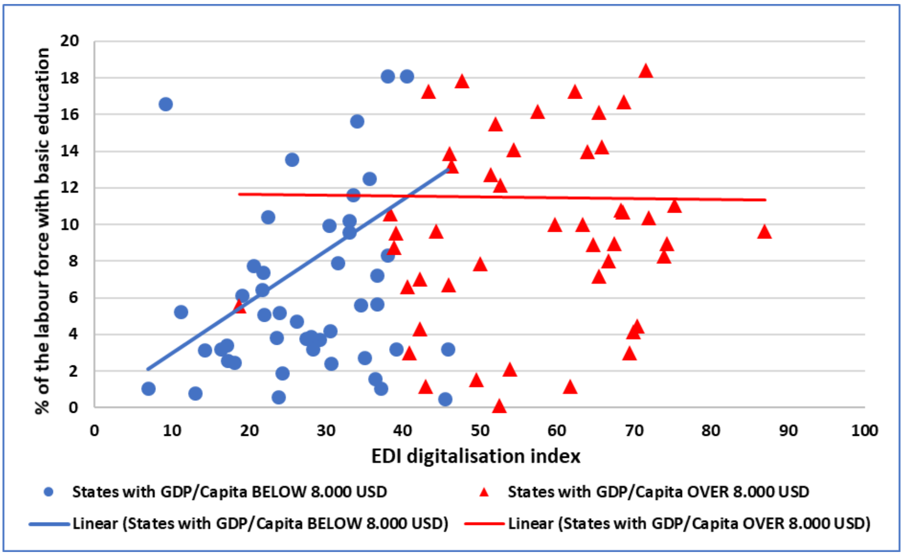

Figure 13. Unemployment with basic education (% of labour force)

It can be confirmed, that according to the rules of the digital economy, the qualifications of employees may be of key importance for the level of unemployment (Figure 13 and Figure 14).

It must be admitted that the strength of the correlation between the level of digitisation and unemployment in the groups "Unemployment with basic education" and "Unemployment with advanced education" is not evident. Nevertheless, the observed dependencies justify two conclusions. Firstly, unemployment with basic education grows particularly dynamically with the level of digitisation in developing countries, while in the group of highly developed countries it is not strongly related to the level of digitisation. Secondly, unemployment with advanced education is extremely diversified in the group of developing countries, while in highly developed countries, the increase in digitisation clearly reduces it.

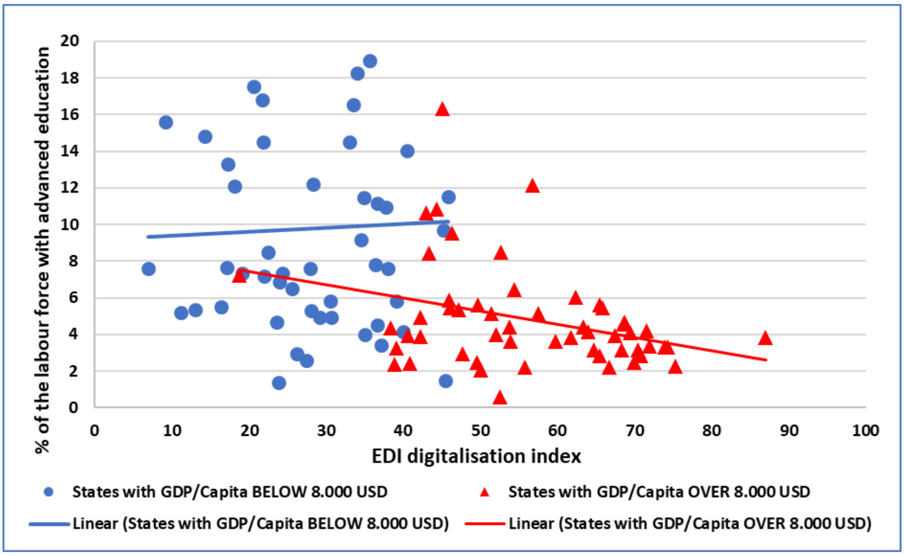

Figure 14. Unemployment with advanced education (% of labour force)

7.5. Equity and poverty

The low level of unemployment should foster the reduction of social poverty, which is a barrier to economic development. The subject of the analysis is therefore the relationship between the level of digitisation and the "poverty headcount ratio at $ 5.50 a day" (% of the population) (Figure 15).

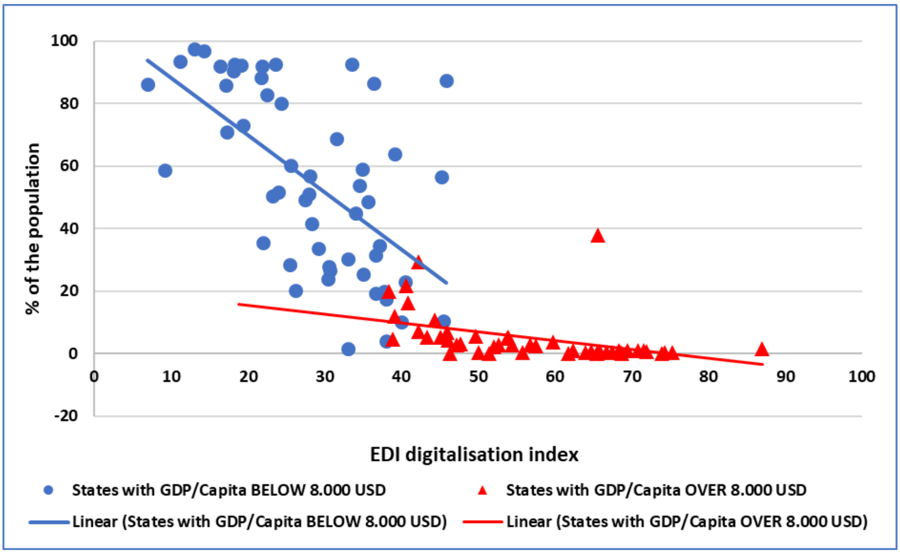

Figure 15. Poverty headcount ratio at $5.50 a day (2011 PPP)

The first conclusion entailing from this dependence is a very strong separation between the groups of countries with low and high GDP per capita, referred the level of digitisation. This points to the potentially very large impact of digitisation on reducing the level of poverty. Moreover, in the group of developing countries, the increase in digitisation entails a very strong reduction of poverty. In developed countries, despite the much lower poverty rate, the positive impact of the digital economy is also significant.

In countries with low levels of development, high poverty rates are often accompanied by social inequalities. This means that a large proportion of the population lives on $ 5.50 a day, while a few are immersed in extreme luxuries. A commonly used income uniformity index is the Gini index (Figure 16). Its value ranges from 0-100%. Values close to 0 indicate an even distribution of income, while those close to 1 confirm a high concentration of income within a narrow social group.

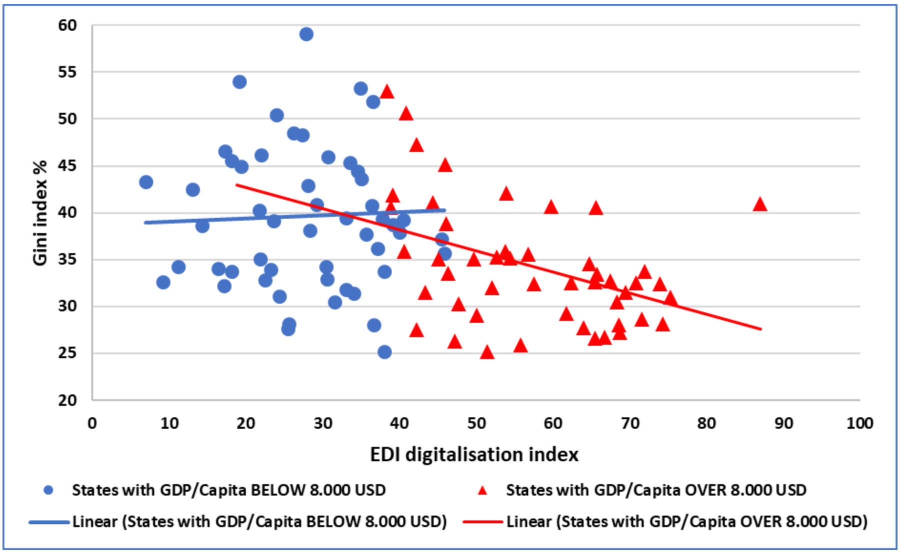

Figure 16. Gini index (World Bank estimate)

Figure 16 presents the rather negative statistical relationship between the level of digitisation and the Gini coefficient. This means that the digital economy fosters the egalitarianism of income. However, the more inquisitive analysis confirms this relationship mainly in the group of highly developed countries. For developing countries, where digital technologies are mainly used to automate production and thus increase its efficiency, the disproportions in the social distribution of wealth may be even greater than before.

7.6. Consumption

Permanent and full employment to the population supports GDP growth mainly by strengthening consumption. A society with higher income levels is more likely to increase consumption, which is the engine of the economy. One of the indicators indirectly illustrating the society's propensity to consume is Domestic credit to the private sector by banks (% of GDP) (Figure 17).

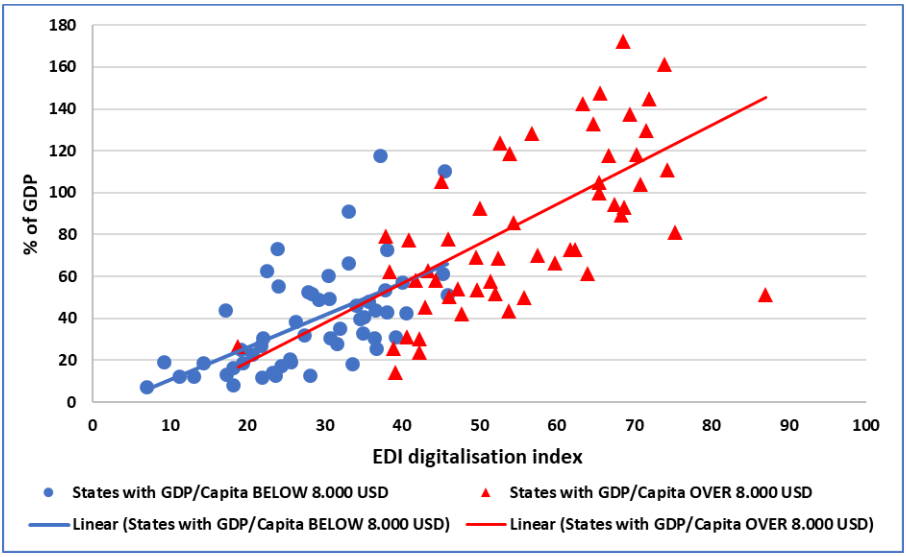

Figure 17. Domestic credit to the private sector by banks (% of GDP)

Figure 17 illustrate, that there is a close relationship between the level of digitisation and the use of bank credit as a source of private sector financing. It should be emphasized that this indicator shows not only an increase in consumption but also in private sector investment which is the second key component of GDP growth. The overall dependence of consumption growth and investment financed with credit on the digitisation index is similar in both groups of the countries.

7.7. Energy consumption and environmental aspects

Nowadays, the key aspect of the economy's efficiency is its energy consumption and environmental impact, related to the use of fossil fuels. The basic measure of energy consumption is “energy use per capita”. It can be concluded that the dependence of energy consumption on the degree of digitisation is similar for all the countries. Unfortunately, contrary to popular expectations, this is a positive correlation (Figure 18).

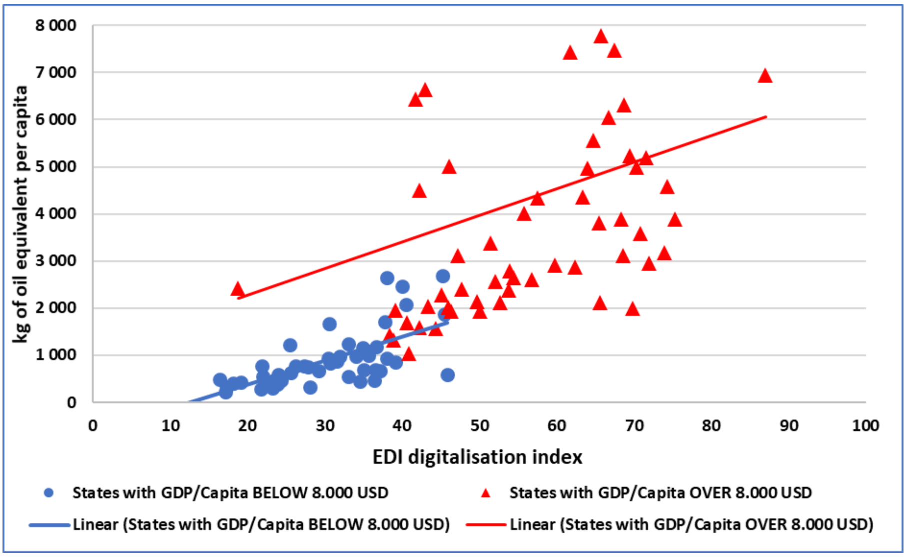

Figure 18. Energy use per capita

Countries with a higher level of digitisation are characterised by a higher level of energy consumption per capita. Moreover, in the group of highly developed countries, energy consumption is also significantly higher in absolute terms. The conclusions entailing from this analysis are not unequivocal and must be assessed concerning positive dependence determining the size of GDP per unit of energy use (Figure 19).

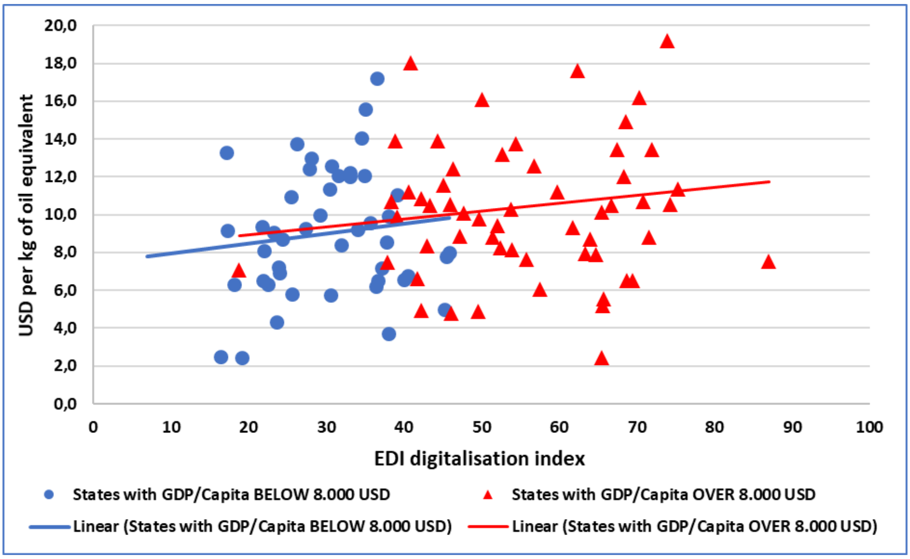

Figure 19. GDP per unit of energy use

Only a comparison of both relationships allows us to conclude that countries with a high level of digitisation are more efficient in terms of energy use for generating GDP. However, given the strong and positive relationship between the level of digitisation and GDP per capita (Figure 8), also the total energy consumption per capita is inevitably higher for technologically advanced countries. Nevertheless, it can be concluded that high technological development allows for higher economic growth with relatively lower CO2 emissions (Figure 20).

On the other hand, however, in developing countries, where the industry determines the economic growth, the higher level of technological development is still accompanied by relatively higher CO2 emissions per GDP unit.

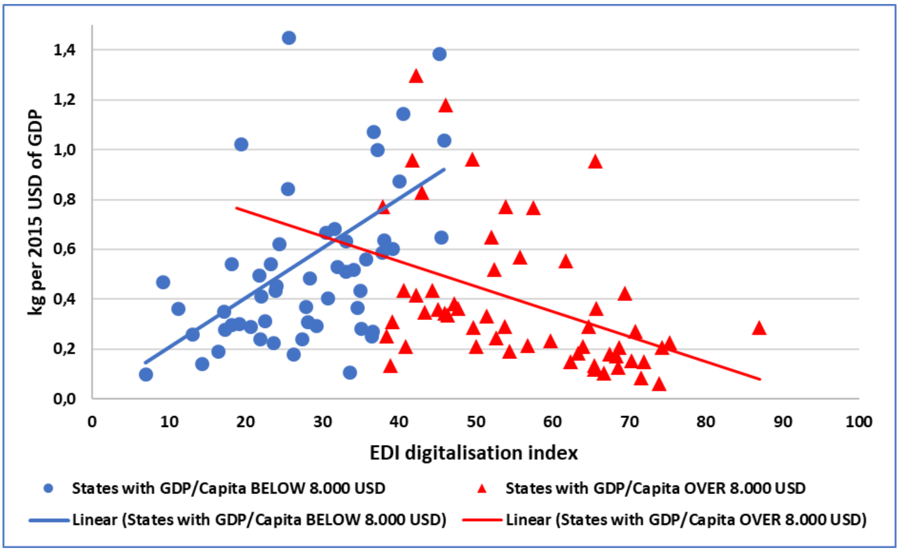

Figure 20. CO2 emissions per GDP unit

7.8. Research, development and education

It is widely believed that innovation is the driving force for the growth of information economies. The basic capital of these economies should include R&D sector and a highly educated society. The selected dependencies fully confirm this thesis. Research and development expenditures are higher for the countries with a high level of digitisation (Figure 21).

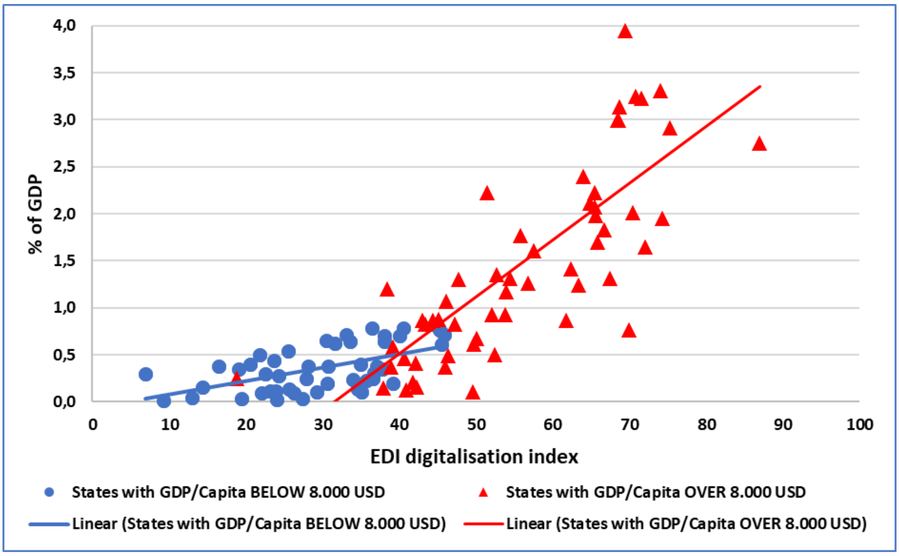

Figure 21. Research and development expenditure (% of GDP)

The dynamics of this dependence is higher for developed countries. This may suggest that highly developed countries are the creators of innovations and modern technologies, while the developing countries are still dominated by the technological beneficiary model.

As economists are confident in the association between innovation and growth, they are far less certain about what drives innovation. Many have offered theories describing the conditions that give rise to innovation. They all point to the obvious relationship between the innovativeness of the economy and the level and quality of education (O'Sullivan, 2019). Indeed, in all the countries, a higher level of digitisation is accompanied by a higher level of government expenditure on education (Figure 22).

An important factor contributing to catching up in the area of education & R&D is the quality of education. Identifying businesses as “incredible platforms for change”, every politician and business leader can have a direct role in creating economic opportunity for millions of people by investing in education and training programs for existing and potential talent (Benioff, 2017).

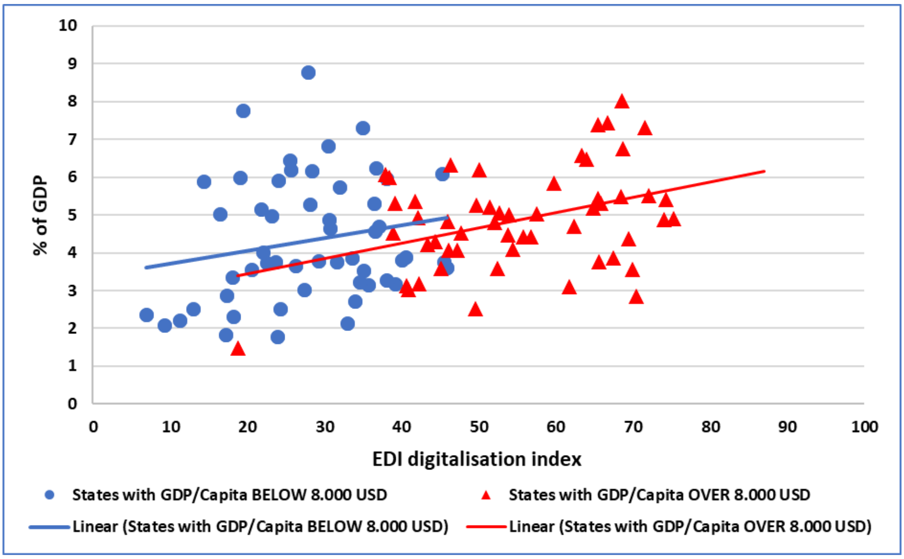

Figure 22. Government expenditure on education (% of GDP)

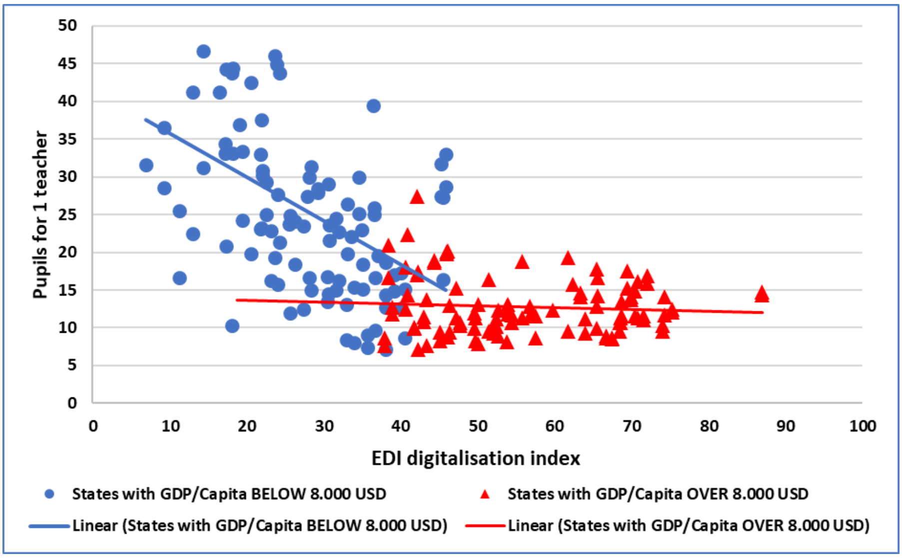

Figure 23. Pupil-teacher ratio (primary and secondary schools)

A synthetic measure of the impact of digitisation on the quality of education in developing countries is strongly related to the digitisation, the pupil-teacher ratio for primary and secondary schools (Figure 23). In countries with high GDP per capita, it stays relatively low and constant, regardless of the level of digitisation.

8. SUMMARY

The presented in Chapter 7 relationships are statistical. They do not clearly define the cause and effect relationship. In many cases, however, it can be assumed that it is just digitisation that exerts an influence on selected aspects of economic development. Moreover, the analyses cover countries that are in different phases of the industrial revolution. The results obtained are often strongly dependent on whether the economy of a given country is still in the industrialisation phase or maybe in the advanced stage of post-industrialisation.

Regardless of the above-mentioned conditions, most of the studied relationships between the EDI digitalisation index and selected indicators of efficiency and growth are unambiguous. In particular, the correlation between the digitisation of the economy and the Gross National Product per Capita is extremely clear. This dependence is also confirmed by the greater use of bank loans and the high contribution of services in all the surveyed countries. In turn, the opposite direction of the relationship between digitisation and the contribution of the industry for developing and developed countries confirms their anchoring at various stages of the industrial revolution.
Digitisation seems to reduce poverty, although its impact on equality is not so obvious. Also, the research on employment shows, on the one hand, the need for highly-qualified staff (and at the same time decreasing demand for staff with basic education), but on the other hand, they point to significant differences in this respect between the analysed groups of countries.
A widely discussed issue is the presumably positive impact of digitisation on the ecological aspects of economic development. Unfortunately, the presented dependencies are not overly optimistic. The overall level of energy consumption per capita increases with the digitisation of the economy, but at the same time, GDP per unit of energy consumed is growing. The relationship between digitisation and CO_2 emissions is shaped as inverted U, confirming the differentiation of economic models between the groups “below 8000” and “over 8000”.
And finally, research and education. A higher level of digitisation also means a better quality of education and higher spending on R&D and education.
The basic nature of the research does not diminish the clarity and, to a large extent, compliance with the expectations. The value of the results is also favoured by the large size of the research sample. A more detailed study would require a more in-depth verification of the used measure of digitisation (taking into account also particular components) as well as verification of the impact of digitisation on the other

premises of economic development. While the basic indicators clearly prove the success of innovation and the Fourth Industrial Revolution, still the other quantitative and qualitative perils may largely be omitted by researchers (O'Sullivan, 2019). “In the coming decades, we need to establish guardrails that keep the innovations of the Fourth Industrial Revolution on a track to benefit all of humanity. We can all individually have a direct role in shaping our future, and creating economic opportunity for millions of people by investing our time and resources in helping others” (McGinnis, 2020).

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COMMUNICATING SUSTAINABILITY IN THE CIRCULAR ECONOMY AND ITS IMPLEMENTATION IN SELECTED AREAS

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Abstract

In the conditions of the Slovak Republic, as well as in the surrounding European countries, we are witnessing a growing number of companies that are implementing the circular economy and its goals, strategies and values, and are making progress in the context of sustainability and renewability. In this way, these businesses are preparing for the future that brings Industrial Revolution 4.0 and will significantly influence the years to come. Industry 4.0 represents innovative solutions in various fields, not least sustainability. The aim of the chapter in the scientific monograph, focused on the opportunities and barriers of Industry 4.0, is to present the issue of sustainability in the context of the principles of the circular economy of mostly small enterprises in Slovakia, or Start - ups, and to point out good practices of implementing these principles in business practice. In the individual subchapters, secondary research is carried out, aimed at mapping the level of implementation of circular economy practices. At the same time, the relationship between sustainable marketing mix and environmental marketing communication is pointed out. The subchapter also contains selected results of primary research, focused on sustainable fashion and on the awareness and attitudes of respondents within the framework of sustainable fashion and its justification in the current environmental situation, as well as attitudes

towards capsule wardrobes and relevant issues related to the topics at hand.

Keywords: *Circular economy, Sustainability, Sustainable marketing mix, Communication, Sustainable fashion*

1. INTRODUCTION

Sustainability of a company represents its participation in social responsibility for the protection of natural resources and the preservation of the quality of our environment, which significantly helps to preserve and create conditions for the life of future generations. Measures that conserve natural resources and protect the environment should now be a natural part of every company's culture, irrespective of its size, in the sense of sustainable behaviour. Similarly, the efficiency of the entire process chain, from the supplier to the end customer, should be continuously improved. Thus, the main goal of sustainability for companies is that they take responsibility for their behaviour towards both people and the environment, which could also be linked to their efforts to reach the highest possible sustainable business (Ofertaler, 2017).

At the beginning of 2021, the Government of the Slovak Republic approved a long-term sustainability strategy until 2030. “In the near future, the world will face many new challenges and it is necessary to prepare for them. The vision and strategy for Slovakia's development until 2030 is a national plan to cope with these challenges in the best possible way”, the Deputy Prime Minister said. The programs of the long-term strategy are focused on various areas such as improving the predictability of public policies, the efficiency of the use of public resources and the stability of the business environment (Available at: www.partnerskadohoda.gov.sk).

1.1. Corporate sustainability strategy – as added value in relation to environmental protection

The implementation of a business sustainability strategy is more important than ever in the 21st century and is an essential part of the long-term success of companies. It encompasses the full spectrum of benefits at all levels that a business has, e.g. from its research and development, through procurement, production, sales, logistics, to product use, finishing and recycling, and it also includes those processes that are directly related to the life cycle of the products. Naturally, this also includes environmental aspects such as energy and material efficiency, low emissions, biodiversity protection, various social topics such as staffing, upskilling and employee satisfaction, as well as topics related to technology, digitalisation, e.g. the impact of digital technologies on business processes and their sales and communication.

Ecological and environmental problems are global in nature and it is essential to start tackling them both internationally and locally. To ensure sustainability, products that are made from local resources are increasingly preferred, which not only save costs but also contribute to local development. The government, through its laws and regulations, guides organisations in a socially responsible way, while citizens as consumers enable the survival and development of socially responsible organisations by purchasing sustainable products (Ottman, 2011).

Sustainable development requires all stakeholders to work together on social and environmental marketing activities so that they can meet their own needs without compromising the next generation (Deckert, 2018).

According to Rakic and Rakic (2020) in sustainable development the emphasis is on a holistic approach that integrates with sustainability marketing into 3 dimensions:

- Goals (economic, social and environmental),
- Capital (financial, technological, human, natural and institutional),
- Actors (government, organisations and citizens).

By being responsible and respecting the principles of sustainable business, companies add value and increase their competitiveness. The prerequisite is to align objectives and strategies, to have capital and to respect the needs of the market environment (Rakic & Rakic, 2020).
The dominant theme with persistent and stable content is sustainability, sustainable business development and the close connection with the processes of the circular economy.

2. CIRKULAR ECONOMY – A NEW PHENOMENON FOR BUSINESS ENTITIES

The circular economy is increasingly perceived as essential for the transition to a sustainable economy. It represents a modern and ambitious plan to create an alternative to the linear economy created in the 19th century. It represents a new idea that marks a significant advance in the way products are created, sold and consumed.
Already in 2015, the European Union adopted a package of measures in which it presented recommendations and legislative proposals for the implementation of the circular economy. In 2018, this package of measures was supplemented by specific targets, particularly in the areas of recycling and waste prevention. In 2016, 193 countries pledged to fight together for a better future for our planet by signing the UN 2030 Agenda, which presents 17 Sustainable Development Goals. In addition to strong support from major international organisations, the transition to a circular economy requires, in particular, systemic solutions at national and regional level. However, such localisation is difficult and faces many challenges and obstacles. Those concerning Slovakia in particular are:

- low awareness of the circular economy,
- the difficulty of communicating its nature and importance,
- the lack of state funding needed for large initial investments, or the difficulty of accessing funding,
- insufficient investment in the public system, research and education,

- poor stimulation of the SME sector, including support for green investments and digital technologies,
- the overall absence of an integrated strategy for the transition to a circular economy.

Despite the relatively unfavourable conditions, Slovakia does not want to be left behind and has high ambitions for the transition to a circular economy within Central European countries. We thus present the issue of the circular economy from different perspectives.

The circular economy is an economic model based on the (re)recycling of materials, components and products back into the production process. By circulating them, it radically minimises waste, the consumption of energy otherwise needed to produce new inputs and the overall cost of production. The most efficient use of resources within the technical and biological cycle is the closing of material flows, i.e. the continuous conversion of production outputs into inputs. The circular economy therefore aims at the highest possible utilisation and value of products and components, as well as a minimum burden on the environment. Due to its ecological, technical and economic potential, the circular economy is growing rapidly in popularity and is thus an increasingly realistic alternative to the linear economy (Available: www.odpady-portal.sk, 2017).

In 2017, the Slovak Institute of Circular Economy INCIEN published a brochure stating that “switching from a linear to a circular economy is not a voluntary choice for people and businesses, but an obligation” (Available at: www. incien.sk, 2017).

Many experts, economists, ecologists and politicians started to think about the circular economy in the second half of the 20th century, when environmental protection started to be more widely discussed. It is only in the last two decades of the 21st century that we can observe a significant rise in the use of circular economy principles. The strategic potential to use as few resources as possible while promoting growth means that the world's largest companies, as well as national and regional economies, are rapidly incorporating it into their concepts.

Finland was the first country to publish a roadmap containing steps to implement the new sustainable economic framework (Robertson, 2017).

Countries such as Japan and Sweden, which are working to increase metal recycling, and Denmark, which is fighting against the construction of incinerators, have also made significant steps forward. Similarly, the European Union has adopted a legal framework to strengthen recycling and prevent the loss of valuable materials (Braw, 2017).

The Ellen MacArthur Foundation, which aims to support and accelerate the transition to a circular economy, estimates that these ideas could generate annual material savings of more than one trillion dollars by 2025 and create jobs through remanufacturing and recycling of products (Males, 2017).

In Europe, the circular economy represents a model through which to contribute to economic growth and significantly impact countries' economies. It does not only represent a new idea, but it shows a shift in the process in which products are produced, sold and is shown the way in which consumption itself occurs and last but not least the education of people to perceive this shift (Musová & Drugdová, 2021).

Currently, we are seeing the rise of the circular economy, which is considered as a scientific concept of a sustainable development model in the economy. “Industrial ecology is a research discipline that is based on a systems approach and incorporates a holistic approach in dealing with human economic activity and sustainability” (Drugdová, 2021).

The priority of circular economy is mainly considered to be the saving and efficient use of natural resources, making the production of products more efficient by consuming fewer resources and recording savings (Cséfalvayová et al., 2017).

According to Sauvé et al. (2016) circular economy contains three principles of “3R” (Reduce - Reuse - Recycle), which are also a code of conduct based on economics.

Reduce - the principle of reduction - the economy is oriented towards scientific and technological progress. Innovations are part of this process and aim to make the use of natural resources more efficient with low use of raw materials and low energy consumption. High-tech technology should be used as much as possible. Specify direct inputs to replace material inputs in order to achieve ecological, economic and social stability of production in relation to the environment. Preference shall be given to smaller and lighter products. Packaging technology favours simple and practical packaging over luxury packaging, which also generates more waste.

Consumers should favour the use of green energy, i.e. solar and wind energy, bio-waste and thus contribute to reducing pollution.

Reuse - the principle of reuse - consumers expect products and packaging material to be produced that can be reused. This means a call to focus on manufacturers and designers who focus on designing products that are both durable and reusable. This would also significantly extend the life cycle of the products in question. By using renewable resources, the production of negative environmental impacts will also be reduced in direct proportion.

Recycling - the principle of recycling - the reuse of products and products at the end of their useful life as an available resource. It is essential to promote the development of a recycling industry that will bring waste and scrap into production or other uses. The aim of this process is to avoid their final disposal (Sauvé et al., 2016).

The above principles are based on ecology and are favourable to sustainable development. The outcome of the mentioned practices will be related to the solution of a complex product life cycle that starts with the design and ends with the end-of-life, which includes recycling, reuse, but also disposal without negative impact on the environment.

Many people are of the opinion that the circular economy consists only of recycling. This view needs to be challenged, not least through greater promotion of the various principles of the circular economy. The circular economy in certain stages focuses on product eco-design, on responsible consumption and only in the last stage does it deal with recycling. Product design must be considered the most important part. The basic task of this step is to design and manufacture the product in such a way that it does not generate waste at the end of its useful life. At the same time, these products must be repairable, reusable and made from materials that are recyclable (Figure 1). Today, we already know of products that are characterised by these properties. Some smartphones, for example, meet these conditions. It is to be hoped that there will be more and more companies oriented in this way in the future.

Figure 1. Principles of the 3 Rs
Source: Circular Economy Overview (https://www.ellenmacarthurfoundation.org/circular-economy/overview/concept)

Another component of the circular economy is responsible consumption. We associate the term responsible consumer with this concept. It is the consumer who seeks out products for the longest possible consumption. He looks at whether the product can be repaired, what service the company provides and the length of the warranty. Only a responsible consumer looks at a product as future waste. The more he buys, the more is produced. This is something to think about when making a purchase.

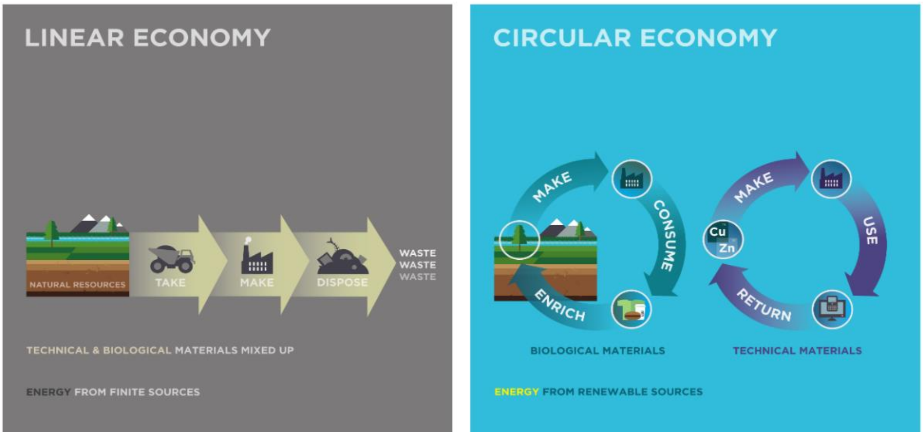

Figure 2. Diference between linear and circular economy
Source: https://eliademy.com/catalog/oer/design-for-a-circular-economy.html

If we have designed the design correctly and the product has been used for a long time, waste has been created over a long period of time. However, the reality is different and products end up in the bin very quickly (Drink straws, polystyrene lunch containers, etc.). A lot of this waste is non-recyclable and ends up in landfill. However, if we worked with eco-design, we could sort all the material, recycle it and put it back into circulation in the same form. In this way, only a small amount of mixed municipal waste is generated. For this reason, it is also necessary to carry out an analysis of mixed waste to see what else could be recycled. It is clear from the above that eco-design and the promotion of recycling should be a matter of course for companies.

2.1. Benefits and barriers to the implementation of circular economy principles

A growing number of companies that implement the circular economy (production programme, organisation portfolio, company policy, values, goals or strategies) are making progress in the context of sustainability and renewability. “In this way, these businesses are preparing for a future that brings industrial Revolution 4.0 and will significantly impact the years to come. The positive aspects of the cyclical economy give them a competitive advantage" (Matejov & Vanova, 2018). A survey by the European Commission found that for 41% of companies, the implementation of resource efficiency measures reduced production costs over a two-year timeframe. This is confirmed by a study by the Slovak Business Agency: 'pan-European SMEs are motivated primarily by financial reasons in the form of cost efficiency improvements' (Slovak Business Agency, 2018). According to the European Commission (2018), if businesses increase resource efficiency, use circular economy solutions or principles and enter green markets, they will increase their productivity and competitiveness, create new jobs and thus contribute to the growth of society. Thus, if the circular economy requires change and the involvement of all market actors at all levels of the economy, its effect is equally multiplied. Loučanová (2017) argues that eco-innovations as part of the circular economy are now the desired innovations due to the growing interest of consumers. This fact makes them a tool for building business competitiveness.

According to the European Commission survey (2018), the most complex barriers faced by SMEs in the process of implementing resource efficiency measures are: administrative and legislative procedures, the cost of environmental measures, the complexity of adapting environmental legislation to the conditions of the enterprise, the lack of specific environmental expertise, and the complexity in the process of selecting the right measures for the enterprise (Drugdova, 2021).

According to Ghent and Matei (2018), lack of human resources and lack of expertise in implementing circular economy measures are the most frequently cited barriers. Ritzén and Sandström (2017) declare that the most frequently highlighted barriers by the respondents in the conducted study are financial barriers (lack of business studies showing possible revenues), technological barriers (quality of recycled materials) and barriers related to supply chain (responsibilities and dependencies).

The barriers defined are linked to the essence of the circular economy - barriers related to the process of closing the material cycle (closed-loop), delivering a new offer to the customer, creating requirements for suppliers and customers, and creating a whole new supply chain.
Rizos et al. (2016), Drugdova (2021) list the following persistent barriers in the process of implementing the circular economy in SMEs:

- insufficient environmental corporate culture,
- lack of capital, technological innovation (in small enterprises),
- lack of state support or lack of effective legislation,
- lack of information, administrative complexity,
- lack of technical and technological know-how,
- lack of support from supply and demand.

Antikainen et al. (2018) state that information-related problems currently represent one of the main barriers associated with the implementation of the circular economy. These are mainly the lack of availability of information, increasing transaction costs and lack of knowledge. Drugdova (2021) further states that barriers in the corporate sector remain: the absence of tax incentives, poor access to capital in order to invest in infrastructure and innovation, regulations favouring recycling over reuse, and weak financial and legislative frameworks. In 2021, the biggest barrier was the lack of use of circular economy was lack of knowledge (knowledge and know-how, 40%), technological and digital innovation (28%).
The more the circular economy is promoted, the more businesses will implement their own technological solutions and such solutions will bring more examples of good practice.
So far, good practice examples seem to be the most used tool in promoting but also educating about the circular economy. According to Patwa et al. (2021) it is not possible to achieve an effective circular economy without consumer involvement. Behavioural change achieved through appropriate communication and education is key, which will lead to the adoption of circular economy culture in the society. Emerging economies are "struggling" with all the steps of the

transition to the circular model because this change is generally considered to be a costly investment.

This is also why it is crucial to better inform businesses and organisations about the benefits in the long term. Showcasing successful examples of practices that apply circular economy principles and that have become more resource efficient through new technologies, reducing costs and creating new markets, will also promote the circular model in emerging economies.

The benefits arising from the implementation of circular economy principles can range from financial, technical or technological to social. However, the authors mostly agree that if a company adheres to the principles of the new economic model its benefits will be mainly:

- reputation building,
- strengthening brand equity as well as increased customer loyalty,
- cost savings and thus increased profits in the long term
- gaining a new competitive advantage.

The biggest benefit for Slovak companies is cost savings, but many of them had to face several obstacles in the process of implementing the new economic model into company practice. Enterprises that are working in this area consider weak support from the state as the biggest barrier, those that are still considering the transition mentioned lack of knowledge as the most important problem. The circular economy has a chance to realise its potential only in the case of cooperation of all market participants, and it is here that its application often fails, according to both authors and enterprises. Given the topicality of the issue and the related lack of experience, it should be said that the adaptation of such a complex and complicated model requires time to acquire sufficient knowledge and practical skills, both at the micro and macro level of individual economies (Drugdova, 2021).

3. EXAMPLES OF GOOD PRACTICE IN CIRCULAR ECONOMY PROCESSES IN SLOVAKIA

The primary role of the state in the transition to a circular economy is to adjust policy instruments to create appropriate framework conditions for the transition, taking into account the importance of the vertical and horizontal integration of the circular model. Since 2016, the Ministry of the Environment and the Ministry of Economy have implemented a number of conferences, workshops or other events and activities to promote the feasibility of circular economy processes and sustainable development. These include in particular the conference entitled Transition to Green Economy, the continuation of Driving towards Circularity with the introduction of zero waste principles, the Bratislava Smart Region conference.

The document Economic Policy Strategy of the Slovak Republic 2030 came into force in June 2018 and continues to date, where "one of the objectives of the strategy is to develop a Concept of Circular Economy of the Slovak Republic with a focus on the entire life cycle of the product, first from the perspective of efficient production and consumption, and then from the perspective of the product not as waste but as a source of reusable raw materials" (www.mhsr.sk, 2018). Another measure was the development of a Raw Materials Policy for Slovakia by 2030. This plan focuses on 'critical raw materials for economic development' and identifies 'smart technologies for energy, economic and environmentally efficient processing of raw materials and waste'. Until the end of June 2018, Slovaks could apply for subsidies of €5,000 per person for the purchase of electric and plug-in hybrid vehicles. The Ministry of Economy and the Association of the Automotive Industry of the Slovak Republic (ZAP SR) have allocated a total of EUR 5.2 million for these subsidies within the framework of the electromobility support project, while a total of 831 applicants have expressed interest in support for the purchase of vehicles. The main objective was to increase interest in purchasing these vehicles, but the Ministry's initiative was also met with criticism. As the subsidy per person is spread over three years and covers an average of 10% of the vehicle price, it remains questionable whether this amount could not have been used more efficiently, for example, for the construction of charging station infrastructure. The Ministry of the Environment has prepared a new document on waste management as of 2019, as Slovakia lags far behind its neighbours in terms of compliance with the waste management hierarchy. While in the Czech Republic 45 percent of municipal waste ends up in landfills annually and in Austria only 4 percent, in Slovakia it is as high as 67 percent. The most anticipated change that should move Slovakia more towards waste prevention, sorting, recycling and thus the overall circular economy is the change to the law on waste disposal fees, effective from 2020.

Companies that are not primarily based on the principle of a circular economy are thus taking concrete measures to increase their competitiveness. The transition to a circular economy is associated with positive impacts on society. In practice, however, it brings with it a number of challenges, for example related to the limitations of current technologies for recovering valuable materials from waste and recycling materials, the changing properties of recycled materials, the development and production of materials with a longer lifetime, and the improvement of waste management.

The MOVECO project responds to these challenges and aims to contribute to improving the framework conditions and policy instruments to promote eco-innovation and thus the transition of the countries in the Danube Region towards a circular economy. The first major positive development in the private sector is that foreign investors have shown interest in Slovakia. For example, a PET bottle processing plant with a planned capacity of 30,000 plastic bottles and mixed plastics will be added within 2 years, which represents a quarter of the plastic packaging placed on the Slovak market annually. This EUR 8.5 million investment by the Green Group will create almost 100 jobs, but it represents only the first phase of a more complex Green Group project in Slovakia, which mainly recovers plastics in terms of materials, for example by producing components for the

automotive industry. The plant was originally scheduled to start up at the end of 2018, but the project is still under discussion.
One of the most common anti-waste measures is just returning secondary raw materials to production. With its Ekovir programme, Curaprox is another example of reducing waste and shaping responsible consumerism. As part of Ekovir, Curaprox has launched a number of projects through which it recycles used toothbrushes, produces bins for sorted waste, is dedicated to minimising waste generation in schools, offices and, most recently, is working to redesign the toothbrush so that recycling it is less burdensome for the environment.
From 2018, IKEA customers can offer their unwanted IKEA furniture through the Second Life of Furniture service, which is part of IKEA's circular strategy. Customers will receive a refund card for their furniture, with an amount equal to a specified price of the furniture, which they can use when purchasing new goods from IKEA. The actual sale or recycling is then taken care of by the store. The companies are also optimising their production processes and services to be more environmentally friendly. An example that has become more widespread in recent years is taxi services that use hybrid and electric cars such as Ekotaxi, Taxieko or the Hopin app, where you can find them marked with a green pin.
The fight against food waste is one of the other big themes that is gaining more and more supporters in Slovakia too, from production to consumption. Despite the fact that shops produce only 5% of food waste, some retail chains have adopted strategic food waste prevention measures. One of them is Tesco, which, among other things, has improved monitoring, abolished x+1 free promotions and launched a 'perfectly imperfect' programme to sell 'ugly' fruit and vegetables.
Another leader, Metro Cash and Carry, is trying to optimise its internal processes with its Zero Waste programme and is also working on developing a system for analysing data on donated and discarded food. Both companies regularly contribute to the Food Bank of Slovakia.

Boxed food sales are also a growing trend in Slovakia, mainly fruit and vegetables grown by Slovak farmers. The aim is to shorten the food chain and support local and organic small-scale production. The pioneer of such sales in Slovakia is the Debničkári, which operates all over Slovakia. They see the added value of their business mainly in the fact that they represent a real alternative for people, who thus have a choice “whether to support an unknown producer in the supermarket or a particular farmer from the countryside”.

As other contributors to food waste, restaurants can also prevent food waste through the Hungry Slovak mobile app, through which they advertise at reduced prices the food they do not sell on the premises.

Not only products, but also packaging is a major burden on the environment. In the case of food, packaging is even the most significant waste component. Many restaurants are therefore turning to greener solutions in the form of eco-packaging. The Menučka.sk portal has prepared a list of establishments that are following this growing trend in order to highlight the fact that the environment can also be supported in this way.

Yeme is a Slovak grocery store chain whose concept emphasises localism. That is why the chain sells the most food from small Slovak producers. In cooperation with the Institute of Circular Economy (INCIEN), Yeme has introduced a circular economy concept that emphasises waste prevention. The company thus reaches for compostable alternatives and efficient recycling of the waste that inevitably arises in its operations. However, according to the Business Leaders Forum, small steps are not enough to bring about widespread change and are more a reflection of the fact that companies do not see the circular economy as “existentially necessary”. Given the difficulty of this process, Slovakia still has a long way to go, which requires greater involvement from the state to allow easy access to support funds. Another key factor is the lack of pressure from consumers, which is, however, increasing. According to a survey conducted by the Pontis Foundation with the FOCUS agency, in 2018, 42% of the Slovak population purchased targeted organic products, including those that were slightly more expensive than conventional products (Pontis Foundation, statement to INCIEN, 2019)

It is therefore no surprise that there are more and more green businesses in Slovakia that have circular economy ingrained in their DNA. Among composters, JRK Waste Management has managed to get to comprehensive waste prevention solutions within its e-shop offering a wide range of eco products with a focus on waste minimisation.

One of the biggest polluters of the environment is the textile and clothing industry. SK-Tex responds to this problem with its concept through which it processes textile residues, especially into insulation. It also works to raise awareness through articles. In this way, it seeks to raise awareness of textile waste. The main aim of the awareness-raising is to include textile waste in the legislation, which does not consider textiles to be waste and therefore does not react to the problem with measures. Fashion Recycling Lab is the first brand that brought the concept of upcycling various textile products to Slovakia and turning them into clothes or changing their purpose. The brand is still active today and its originality contributes to the reduction of textile waste. The BagBet brand is the shirt designs of a young student who is trying to highlight the overproduction that characterises the clothing industry. They breathe new life into textile waste. BagBet pieces are made from quality materials such as cotton, linen and hemp and have already won many fans with their simple yet unique eco-design.

Créeme is a slow fashion brand that produces underwear and t-shirts made from naturally beige cotton and is proof that there is beauty in simplicity and naturalness.

Cila is another popular fashion brand from Slovak manufacturers who offer collections for all age groups. With their minimalist designs and cuts that span several sizes, Cila items are evergreens in every wardrobe.

As it is obvious from the name, the shop Nosené recycles clothes which it sells in its stores in Bratislava, Banská Bystrica and on its own

e-shop. It is a unique concept. As one of the few second-hand shops, Nosené accepts items from individuals, designs and sells its own upcycling pieces, and proceeds from the sale of all the clothes go to organisations helping abused women.
Dutka processes leftover textiles mainly into household products such as pouches, bags, towels or handkerchiefs. The main aim is to find new uses for textiles that no longer fulfil their original function. In addition to actual production, the young entrepreneur organises workshops during which participants can make their own grocery bags using only a needle and cotton.
At the end of 2017, Crafting Plastics presented its first ready-to-wear eyewear collection made from a new generation of renewable plastics that are 100% degradable. They are proof that every fashion sector has sustainable alternatives, bringing transparency to the industry.
The Plastic brand combines recycling, design and usability in one. It is the project of two long-time friends who decided to embark on a worthwhile activity in which they would also apply their DIY skills and ingenuity. So they literally made a plastics processing laboratory at home. As complete novices, they naturally started with simpler items, but today we can also find wall clocks or their famous men's bow ties in their offering.
Proof that Slovaks have golden hands is also Nice architects. Their Ecocapsule immediately became a globally sought-after item and was written about by the world's media such as The Telegraph, CNN or the Mirror. It is a luxurious off-grid house with a timeless design that uses both wind and solar energy to power its march. Thanks to its compactness, you can easily transport and fold it anywhere in the world.
“Recycling, functionality, design” is the motto of Pure Junk, a company dedicated to interior design for homes and businesses, as well as product design for furniture. It takes waste reduction as its mission, and therefore works with waste collectors and construction companies that produce wood waste to turn it into creative and functional interior design solutions.

The Good Market was established in 2011 and was founded on the initiative of the Punkt Civic Association, which regularly organises it several times a year with the aim of creating a place for encounters and experiences.

It promotes small-scale producers and quality domestic products, as well as products from diverse cultures and ethnicities. It cultivates alternative lifestyles. The Good Market has grown year on year as an event and so has the amount of waste left after the event. Therefore, its organizers decided to team up with INCIEN to co-create a concept that would help reduce waste. Over a year of intensive collaboration and trying out different models that could work, together we created a model that reduced the amount of mixed municipal waste from 70% to 5%. This model has already been adopted by other events such as Streetfood Park in Bratislava, Trnava Rinek in Trnava and Festival Pohoda.

Festival Pohoda is the largest music festival in Slovakia. In 2017, the festival won The Green Operations Award at EFA 2017, an international award for the measures put in place to reduce its overall ecological footprint. The event organisers decided to reduce the amount of waste that ends up in landfill and place more emphasis on waste sorting and prevention through a system developed in collaboration with INCIEN. The Street Food Park is a regular event that emphasises localism and food quality and also focuses on promoting sustainable concepts. Therefore, as one of the priorities, waste management was also addressed through waste prevention, honest sorting and subsequent composting and recycling (Madajová and Belicová, 2019).

A second chance for textiles was given by a young entrepreneur from Slovakia. who owns a small company called WakiVaki. WakiVaki's main goal is sustainable ethical production. Since its inception, it has applied nature-friendly production practices and supports the seamstresses who sew for the brand. This effort results in simple, practical yet beautiful, original products with quality craftsmanship. It has recycled nearly 200 kg of textile waste and sales of its products are increasing. The company buys leftovers or waste from textile and automotive operations and reuses material that has lost its original use. It gives this material a second chance at life and creates a new simple product out of it that is both very popular and practical. They strives for minimal waste in production, which is why they choose cuts that are "zero waste". All products are handmade in Slovakia.

As an example of the circular economy in Slovakia, we can mention the company Tento, which is dedicated to the production of paper for hygiene and kitchen purposes. For several decades, the company has been regularly going out and buying paper door-to-door, exchanging tons of used paper for their products. The paper they collect is further processed into recycled paper, toilet paper, etc. Thus, this company has been promoting recycling of exhaustible natural resources for a long time.

Furthermore, there are foreign companies in Slovakia that are trying to apply the circular economy, for example by buying old clothes. The Swedish company Hennes & Mauritz (H&M) has for several years been offering to buy old clothes for a voucher worth EUR 1. Customers can bring one plastic bag of old clothes or various second-hand textiles to the store and the company will issue them with a voucher for their next purchase. This clothing is further recycled and then sold with a 'recycled' label. The company mainly recycles denim, which it further processes into jeans, denim jackets and denim shirts.

Another company that, although foreign, tries to recycle in Slovakia is HUMANA. The latter had (and in some places still has) collection containers all over Slovakia. On their website they say that they collect all kinds of clothes and used fabrics, which they further divide into little groups. One part goes to second-hand shops HUMANA in Slovakia, Czech Republic, Poland and Romania and to the wholesale trade. Another part is sent to Africa to be sold to local traders at low prices. This meets the countries' demand, creates local economic activity and generates local resources for development. The remainder is sold in the UK and India for reuse (Available at: www.humana-slovakia.org).

Intimissimi sells lingerie for both women and men. Because the company strives to be environmentally friendly and therefore eco-friendly, it gives old or worn clothing a chance. Visitors to the store have the option of bringing their old clothes and throwing them in a container that is in the store. The collected clothes are then processed and recycled. For a certain number of pieces of discarded clothing that customers place in the container, they will receive a coupon for a purchase at that store. Intimissimi started a similar campaign and continues to develop its concepts throughout the corporate philosophy of Calzedonia, under which Intimissi falls.
The company Bezodpadu.sk claims the following about itself on its website: We are inspired by permaculture and its fundamental ethical pillars: care for people, care for the Earth and fair shares. We recognize the complexity of the problems associated with today's food production and distribution and want to be part of the solution. (http://bezodpadu.sk). The company sells bulk foods, teas and oils. The packaging itself is recyclable and degradable in nature, and the company also offers options to return the packaging to the manufacturer. The company also tries to support local growers as much as possible, although it indicates that sometimes this is not entirely possible. Packaging tends to be glass, paper or cloth bags.

4. SUSTAINABLE MARKETING MIX AND MARKETING COMMUNICATION

In the current period, humanity is experiencing the era of the 4th industrial and technological revolution, which brings with it not only dramatic changes in the environment, but also in society. Irresponsible corporate behaviour and globalisation processes have played a significant role in this issue. A number of studies around the world have shown that customers, employees and investors increasingly prefer those companies that are considered to be socially responsible and, above all, environmentally friendly. Over time, therefore, companies are being forced to rethink their objectives, direction and strategies, particularly at the level of marketing decision-making. The concept of sustainable marketing cannot be considered new, as many companies are reflecting new trends in social responsibility and are striving to implement at least one of the pillars of social responsibility, which is most often the environmental pillar. Marketing objectives must respond to the ever-changing environmental conditions and must move towards new approaches and concepts of marketing - in particular a holistic approach. At the level of marketing targeting, we are seeing a shift or change from the 'traditional' marketing concept to a much broader understanding of marketing as such. Not only sustainable marketing, also called green marketing, but also communication in the green marketing mix is coming under the spotlight.

The primary advance in marketing and societal perception is that companies should recognise that sustainable or green marketing represents a potential source of innovation, competitive advantage and market opportunity.

As marketing is increasingly concerned with environmental or public health issues, traditional models of the marketing environment need to be adapted to this new situation. In particular, it requires a targeted and open approach to environmental and social issues. This also means that, in developing sustainable marketing strategies, a company must rethink all the components of the marketing mix by moving from traditional to sustainable marketing (we also call it green marketing), where the fundamental changes lie in a sustainable - green marketing mix.

4.1. Green marketing mix

Consumers are becoming increasingly aware of the deteriorating quality of the environment. They are more interested in the issue than they used to be and place much more importance on choosing a product that has a minimal environmental impact. Companies are also aware of the demands of their customers and the need for increased

commitment to environmental protection. They are willing to make the necessary improvements and are therefore innovating their product portfolio in relation to nature. Through a carefully thought-out marketing mix, they influence their customers and meet their social and environmental needs (Davari & Strutton, 2013).
A responsible company should be able to implement environmental considerations into every component of its marketing mix. The green marketing mix consists of the basic categories of tools namely the "4Ps" such as product, price, place and promotion, the concept of which is adapted to the issue of environmental responsibility. Other important tools are the employees, the set processes and the material provision of the company. Marketing activities cover a wide range of activities, from modification of the product, its production process, sustainable packaging to green marketing communication (Georgia et al., 2019). Baker (2003) argues that, "marketing success involves ensuring that the marketing mix meets the so-called "4S" criteria. These are meeting customer needs (satisfaction) and safe (safety), sustainable (sustainability), socially acceptable (social acceptability) products" (Baker, 2003).

4.1.1. Green product

There are many factors that influence how a product will be perceived by the end consumers in the market. Based on the nature of the product, decisions are made about its marketing mix, either in a green connotation or not. In order for a product to establish itself in the best possible way, it is necessary that the product meets criteria that not only meet consumer requirements but also are environmentally friendly. A green product does not eliminate waste to zero, it uses resources in its production and consumption, causing negative environmental impacts. Compared to other non-green products, it produces much less to minimal pollution during production and consumption (Moscardo & Murphy, 2020).

Companies have two choices to do business in a greener way, either by producing a new sustainable product or by modifying an existing product to make it more environmentally friendly. An essential part of a sustainable product is certification by a recognised organisation, which ensures that the product meets set standards. Tasteful design and packaging also adds value to attract the attention of customers. All the aspects that the manufacturer can influence allow him to gain an advantage over the competition and thus make it easier for customers to choose the product when buying. Branding plays a very important role in consumer decision-making and especially in green marketing, as the consumer knows the attributes of the brand, which speeds up his choice.

As Paettie (2003) states “the treatment of a product over its lifetime creates opportunities for product management and the use of some or all of the 5Rs”:

- repair - repair without having to buy a new product,
- reconditioning - refurbishment of individual components,
- reuse - reusing some parts of the product,
- recycling - recycling waste at the end of the product life cycle,
- re-manufacture - refurbishing products that are no longer functional and remaking them into new ones.

4.1.2. Green price

Price is one of the decisive factors that influence customers to buy a more environmentally friendly product. Companies attach importance to the quality of the green product, the production and distribution process, its certification, the creation of an attractive packaging design, which in turn is reflected in the increased price of the product. Customers are aware of all the attributes of a green product, know the current state of the environment and are willing to support their production. They are aware of the positive consequences based on their purchasing behaviour towards nature, their health and are therefore willing to pay more for them than for traditional products. The price

they are willing to pay for a greener product also depends on their lifestyle, social and cultural preferences (Almajali & Tarabieh, 2020).
Other factors that influence pricing as the most flexible instrument include the choice of the target market in which the product will be offered, variables related to the distribution and promotion of the product, as well as the influence of competition. Products in general are at different stages of their life cycle in which marketers experience differentiated consumer interest (Kusa, 2021).
The True Pricing method, or also True Cost Accounting, motivates companies that focus their objectives on profit and do not give importance to the social and environmental aspects of their business. Aspects of corporate social responsibility are a good way to reduce the overall cost of producing and distributing their products. As companies think in numbers, the real numbers that a change in business strategy will bring them in the long term are very important for them. This method considers not only the positive but also the negative impacts on society and the environment. By changing their production processes and distribution channels to be more environmentally friendly, companies are able to win favour and meet the needs of their customers more quickly (Kramer, 2020).

4.1.3. Green distribution

Companies that invest in the production of environmentally friendly products are concerned about every component that could have a negative impact on the environment. The distribution of goods from the manufacturer to the retailer is becoming more and more congested due to increasing globalization. Due to the long distances between producer and retailer, different modes of transport are used. The most widely used is certainly road transport, which causes increased production of greenhouse gases and thus contributes to the warming of the planet. Pressure is also coming from consumers, who are demanding easy access to sustainable products from society, whether in bricks-and-mortar or online stores. They are not interested in going to great lengths to obtain them or in paying extra shipping costs (Almajali & Tarabieh).

Socially responsible companies are aware of the environmental impact of transportation and are therefore changing their distribution policy to a local one. They strive to achieve sustainability and therefore shorten their distribution channels, thus eliminating middlemen and thus creating added value for the customer. Green producers and retailers cooperate with each other and thus contribute to reducing the carbon emissions produced in the air. They create independent shops focused on selling green products, as retailers prefer companies with a wide range of products and a diverse offer when choosing the assortment of their stores. This crowds out retailers who, although they do not always have a wide range of products in their portfolio, contribute to sustainable development through their activities (Almajali & Turabian).

The way in which companies are able to save not only finances but also the environment is brought to them by reverse distribution. Compared to green distribution which deals with the environmental impact of distribution, reverse distribution deals with the elimination of wastage of resources. It promotes material recycling by collecting, sorting goods (returned goods, from previous seasons), and packaging from customers and sending the recovered material back to the distributor or manufacturer (Gežík, 2012).

4.1.4. Green promotion

Marketing, because of creating demand for products and services, is partly attributed responsibility for the current state of the environment. Green promotion demonstrates the relationship between the product and the environment, promotes lifestyle, but also the social responsibility of companies. By identifying a segment and using appropriate marketing communications, companies are able to influence the behaviour of both existing and potential customers. Companies adapt the communication mix based on whether customers

are environmentally oriented or just accept environmental considerations. The aim is to increase the company's economic indicators and market share (Bednárová & Jegrová, 2020).
To increase the demand for sustainable products, marketers therefore focus on increasing awareness of the issue under study, the properties, their sustainable alternatives as well as the production processes. Companies are also at risk of being accused of greenwashing or of exploiting social and environmental issues to their advantage when promoting their products. One of the reasons for this is the poor wording of the advertising message, which can have a negative impact on product sales (Baker, 2003).
The communication strategy aimed at improving the public opinion of the company focuses on meeting the environmental demands of customers, also called defensive strategy. Therefore, a socially responsible enterprise most often uses public relations and sponsorship to promote itself, which best enable it to improve its overall public image. Just as a defensive strategy does not seek to change the attitudes of its customers and their purchasing behaviour, an offensive strategy aims to do the exact opposite. It pays particular attention to the environmental characteristics of products and seeks to change customers' purchasing behaviour while maintaining established economic indicators. Companies incorporate tools such as sales promotion and personal selling into their advertising campaigns, which they consider to be very important in the strategy they have set out (Jacinto & Sakal, 2008).

4.1.5. Communication mix in the environmental context

When composing an appropriate set of communication mix tools, a company has to take into account many factors, such as the nature of the product, what stage of the life cycle it is in. It is also important to take into account what market it operates in, what its competitors are and who its customers are (Matthew et al, 2012). Through a well-chosen communication mix, it has the opportunity to influence a wide

range of its target audience. Customers are influenced by emotional appeals that make them feel fearful of threats to their health and life due to the deteriorating state of the biophysical environment.
Environmentally oriented companies use both traditional and non-traditional marketing tools in the design of their communication mix, which are proven to be effective even for products without environmental attributes. They focus primarily on building community and trust with customers. These tools are selected according to the objectives of the companies, the target audiences and the possibilities to implement effective communication mix tools in both offline and online environments.

4.1.6. Green washing

Due to increased consumer pressure and demand for green businesses, enterprises are forced to introduce socially responsible activities into their business strategies and promote sustainable development. Sustainability is becoming more and more popular and this allows companies to parasitize on this concept because of its green connotation. Greenwashing is a form of marketing strategy that a company uses to give the impression that it is green. Companies parasitise social and environmental concerns with unsubstantiated and misleading information and claims about their products, services and activities (Delmas & Burano, 2020).
Through thoughtful marketing campaigns and PR with green overtones, companies can effectively influence the minds of consumers. They umbrella their activities by promoting research, protecting the environment and fighting for equality. These activities should not be the primary objective in creating the impression of a green company, but they should focus their attention on modifying their products for the better. If consumers are not informed enough and do not seek to verify the information they receive, they allow companies to continue to contribute to greenwashing and to increase the negative impact on the quality of the environment (Urbanova,

2018). As a result of retaining this marketing strategy, a company must assume that over time this may lead to damage to its image and a consequent reduction in sales volume and market share (Oates, 2020). One tool to combat the deliberate introduction of greenwashing into companies' marketing activities is eco-labelling of products. Which can cause consumers to get lost very quickly in the plethora of labels, and not make the effort to verify their meaning and veracity. A number of initiatives have emerged to combat greenwashing. One of them is the GreenwashingIndex website, which educates and supports consumers on how to read advertising so that they can decide for themselves whether it is a form of greenwashing or not (Kayal, 2020).

4.1.7. Sustainable fashion issues

Fast fashion represents the mass production of garments that are produced with average to low quality at low prices. They are inspired by new collections from fashion shows or based on trends set by celebrities. Customers buy in a wasteful and polluting way clothes that they only use for a very short time. Fashion in the collective-cultural consciousness is understood as consumerism, materialism, marketing and commercialisation. The approach to fashion depends on our way of thinking, from which point of view we look at the issue. Clothing life cycles have shortened by 50% since the 1990s. The fast-fashion trend is compounded by the ease of buying clothes online, which increases the total number of purchases made and the turnover of fashion chains. By doubling the lifespan of clothes to 2 years instead of 1 year, we reduce emissions by 24% annually, thus reducing the resources needed for production and the rate of waste (Available at: https://storage.googleapis.com/planet4-international-stateless/2018/01/6c356f9a-fact-sheet-timeout-for-fast-fashion.pdf).
Clothes are a part of our daily lives and we wear them all the time and everywhere. Despite providing jobs for hundreds of millions of people around the world, the textile industry is one of the second largest polluters of water and nature. The production of clothing produces a

large amount of waste, which is generated due to a lack of recovery and recycling. Large international fashion companies have shifted their production to countries in the global south to reduce the production cost of their products (Available at: https://ambrela.org/spravy/publikacia-textilny-a-odevny-priemysel-problemy-a-riesenia/).

In countries such as Bangladesh, Indonesia and Cambodia, they employ cheap labour, which allows them to reduce their production costs to a minimum. This is an unethical way of employing people, with their wages being around $12 a month. The problem of so-called fast fashion is not only caused by social impacts, but also by environmental impacts, which bring with them a number of negative environmental impacts. The production of textiles produces an enormous amount of greenhouse gases, amounting to around 1.2 billion tonnes per year. Some textiles, when washed, also release plastic microfibers that contribute to ocean pollution (Available at: https://www.ellenmacarthurfoundation.org/assets/downloads/publications/A-New-Textiles-Economy_Full-Report.pdf).

Cotton, as one of the most widely used materials in the world, contributes to soil and water degradation and destroys biodiversity when grown. Therefore, to avoid crop degradation, around 8,000 different pesticides are used. Only 1% are grown organically and 70% of cotton plants are genetically modified. The extreme amount of pesticides used in cotton cultivation causes around 200 000 poisonings a year. Almost 70% of Lake Aral, which was one of the 4th largest lakes in the world, has already dried up due to cotton irrigation (Hartmann, 2020).

Materials hold an important role in sustainability, they are valuable commodities for farmers, designers, consumers, as well as recyclers. The goal of sustainable fashion is not only to focus on materials in isolation, but also on the ecological, economic and social systems of which materials are a part (Flatcher, 2013).

The use of new methods of reprocessing clothing prevents most materials from ending up in a landfill or incinerator. Recycling or upcycling is the process by which sorted clothing is converted into something of higher quality. Upcycling contributes to the sustainable production and consumption of clothes, which not only does not pollute the environment but also renews their life cycle. It also becomes a kind of added value to waste (Pandit et al., 2020).

Sustainable fashion is characterised by its commitment to the processing of quality materials and the promotion of quality handmade work by local producers and designers. It combines ecological and ethical attributes into a unified movement that promotes a responsible consumer attitude towards buying clothes. The goal is to produce clothing that is timeless and lasts more than one season. This alternative form of fashion promotes a return to roots, values and quality. Supporting Slovak fashion and its creators plays a very important role in the economy, employment and the image of our society and country.

The capsule wardrobe is of great importance in promoting sustainability in the fashion industry, which saves not only wardrobe space and finances but especially time spent in choosing outfits for the next day. A typical capsule wardrobe consists of 40 pieces of casual wear that can be easily combined with each other throughout the seasons. When creating a capsule wardrobe, the key is to keep those pieces of clothing that are most used and can't be given up, and then categorize the clothing according to what activities they will be used for (e.g. work, leisure, entertainment, fitness, etc.). Therefore, when completing a capsule wardrobe, the focus should be on quality materials with a long life. (Available at: https://www.barborayurkovic.sk/kapsulovy-satnik/).

In order to promote sustainable fashion, several initiatives have been created in Slovakia, such as the Sustainability Platform, which aims to spread awareness about the impact of the fashion industry on the planet and our lives. It also focuses on organising SWAPs, the idea of which is to get as many unworn clothes back by lunchtime as possible. There is also an event called Fashion Revolution Week, a global campaign to promote sustainable, transparent and ethical fashion and the fashion industry, which has launched the Who made my clothes campaign. The campaign was created to commemorate the collapse of the Rana Plaza textile factory and aims to draw attention to the fact that people are poorly informed about the conditions in which clothes were made. The #nosimSK initiative in support of Slovak fashion from the Slovak Fashion Council, a non-profit organisation that focuses on supporting local designers during the coronavirus pandemic. The aim is to highlight the offerings of Slovak designers, makers and brands over those of fast fashion (fast fashion) chains (Available at: http://www.slovakfashioncouncil.sk/sk_SK/nosimsk).

5. SELECTED RESULTS OF THE RESEARCH

The Cila brand has been on the Slovak market since 2015 and focuses on feminine, eco-friendly and minimalist fashion (Figure 3). The product portfolio includes every kind of clothing that should not be missing in a woman's wardrobe, such as: dresses, skirts, shirts, trousers, coats, T-shirts.

Figure 3. Logo

The company's main idea is to make it easy to combine individual pieces of clothing, so when creating their designs, they think about the consistency of the entire portfolio. It offers its customers the opportunity to create a functional, but also timeless and modern wardrobe. The brand promotes the idea of a capsule wardrobe. It is a wardrobe that contains about 40 basic pieces of clothing that can be easily combined with each other. Among other things, the brand represents the slow-fashion segment of brands. And that is why the brand strives to educate and inform the general public in this area through its channels. A great benefit of the brand is the local production of products that reflect the quality tailoring craft, which is rare to master nowadays. The brand's mission is to create clothing that meets the parameters of eco-friendliness, comfort and timelessness. For this reason, the target group is women, who are more empathetic to the current state of the environment than men. That is why the Cila brand has focused its product portfolio on this target group, which is much closer to the topic of ecology. The brand's target group is highly specific, they do not shop in conventional fashion chains. It has strong ecological values and cares about nature around it. They are people who are open-minded, interested in the life around them and where they live. They like handmade creations and design. A large part of the target group consists of mothers with children. The product is handmade clothing designed mainly for women, which is created by upcycling or using commercial fabrics with certification. Deadstock is fabric that has been left unused in the production process, either due to damage or overproduction. These are high quality materials, mostly only in small quantities, which are not very attractive to companies and are at risk of ending up in landfill. At Cile, these fabrics are given a new lease of life and made into new and functional pieces of clothing. By upcycling clothes, no new waste is created in the garment industry and the company contributes to the revitalisation of the environment. Other materials from which the Cila brand manufactures its products include linen, merino cotton, cashmere blend and 100% organic cotton, which is GOTS certified, which is considered to be the most stringent international bio-textile certification. It informs the consumer that minimal chemicals have been used in the growing and processing of the cotton plant, making it a more eco-friendly form, as well as safe for skin contact. The products are priced in the higher price range, which represents the choice of quality material, the designing of an attractive design, the human capital and the time spent in assembling the individual products. The price also takes into account the complexity of the processing of each piece of clothing, which varies according to the type of product, i.e. whether it is a more complex product design that requires not only more time, but also more materials and skills than making a product with a lower manufacturing complexity. If a brand wants to promote the idea of sustainable fashion the selection of suitable fabrics represents a very costly but also crucial part of the whole production, which is then reflected in the price of the product.

Handmade and high quality materials guarantee the longevity of the products, which Cila's customers are also aware of and are willing to pay a premium for. By buying, they are not only supporting the local producer, but also the local economy, which results in an increase in GDP, job growth, etc.

The brand has a specific communication mix and does not normally use advertising and push marketing practices in its marketing activities, but instead tries to spread awareness of its brand through pull marketing and other marketing tools. Thus, its intention is to create a natural interest in the brand's activities and products among its customers.

The brand operates and communicates in an online environment. It uses the promotion of its products on the social networks Facebook and Instagram, either in the form of paid posts on a bulletin board or in the form of paid stories. It presents products based on seasonality or when introducing a new collection. In addition, we can see the brand advertising in the offline environment on OOH outdoor advertising at special events, as well as posters and flyers. Although the company operates in an online environment, it does not use PPC search advertising to increase awareness among its customers.

The brand strengthens its public relations and uses communication tools of this kind. The most important activity of the brand is the Fashion Revolution Week event, which the brand organises regularly and the idea is to spread awareness and the idea of ethical fashion. During the event, participants can take part in various discussions about the fashion revolution, watch a film about fast fashion issues, as well as take part in a clothing SWAP. The event is mostly attended by young people who share their photos on social media under the hashtag

#whomademyclothes, which is characteristic of the event. Of great significance for the Cila brand in building positive PR in the eyes of consumers, is winning the Via Bona Slovakia award in the green company category with its circular economy in fashion project.

The personality of the founder of the brand is also a part of the communication mix, which is strengthened by her participation in thematic fairs and events, her activities in the fashion, slow-fashion and ecology segments. The brand most often informs about its presence, activities and products through online PR articles on various web portals, as well as in print in magazines and magazines. It is important to note that these are not paid PR articles, but the media's own interest in the brand's products and activities, which is free of charge. Within the PR articles, SEO optimisation would need to be supplemented and adjusted, to improve the brand's position within Google searches.

The entity has also used well-known personalities/influencers in the past to promote its brand. The website is very important to the Cila brand as it is the largest and most effective channel for the brand. The design of the website is in line with the company culture, minimalistic, soft, in white and grey colors. On the homepage we can see a big bold yet minimalistic banner, basic highlights about the brand, selected product pieces and a description about the brand story. The website has 3 categories namely shop, about us and blog. The shop is the shopping part of the site, where the actual products of the brand can be found, for the actual part, high quality and professional photos of these products are essential. The about us category describes the story and philosophy of the brand, the fabrics used, the idea of the capsule wardrobe and the terms and conditions. The third category is a blog, which contains interesting articles about the brand and recently interviews with various personalities from Slovakia. The website is in Slovak and is also translated into English. The site also allows you to create a personal account that informs the customer about the orders created, allowing them to change delivery and personal data for faster creation of future orders.

Social networks that the Cila brand makes heavy use of include Facebook and Instagram. Within these social networks, it showcases its product portfolio, its loyal female customers, as well as interesting personalities involved in sustainable fashion who are closely linked to the brand. A very interesting collaboration was with photographer Marek Pupák, who approached Alu Kriva to photograph his grandmother in a Cila dress. Together with his grandmother, he has long been creating a beautiful project @bleu.grandma, on the social network Instagram, where he documents his grandmother's life through real, unvarnished and honest photos.
The content on Facebook corresponds with Instagram, with the exception of some posts where the brand shares various inspirational discussions, her achievements, as well as posts about collaborations with other designers. It also includes a shop section where followers of the page can browse the product portfolio and then click through to the cila.me website.
The analysis found that the brand has a predetermined content plan (content schedule) for posting on its social networks and shares posts with a logical sequence. Cila's Facebook brand currently has 4,418 followers. Follower interaction is almost half as much on Facebook compared to Instagram. Figure 3 shows the interaction on social networks Facebook and Instagram in the month of February 2021. From which we conclude that Instagram is more attractive to the target audience of the brand Cila.
The brand interacts very intensively on social networks, it has an increasing number of followers (in 2020 Instagram 3508). The brand promotes social media posts with sponsored advertising, which we consider very positive, as today it is no longer possible to rely on organic reach on social media, which is minimal.
The brand blog is part of the Cila.me website. The articles on the blog are dedicated to inspiring women in sustainable fashion who are closely connected to the Cila brand, but also to its loyal customers.

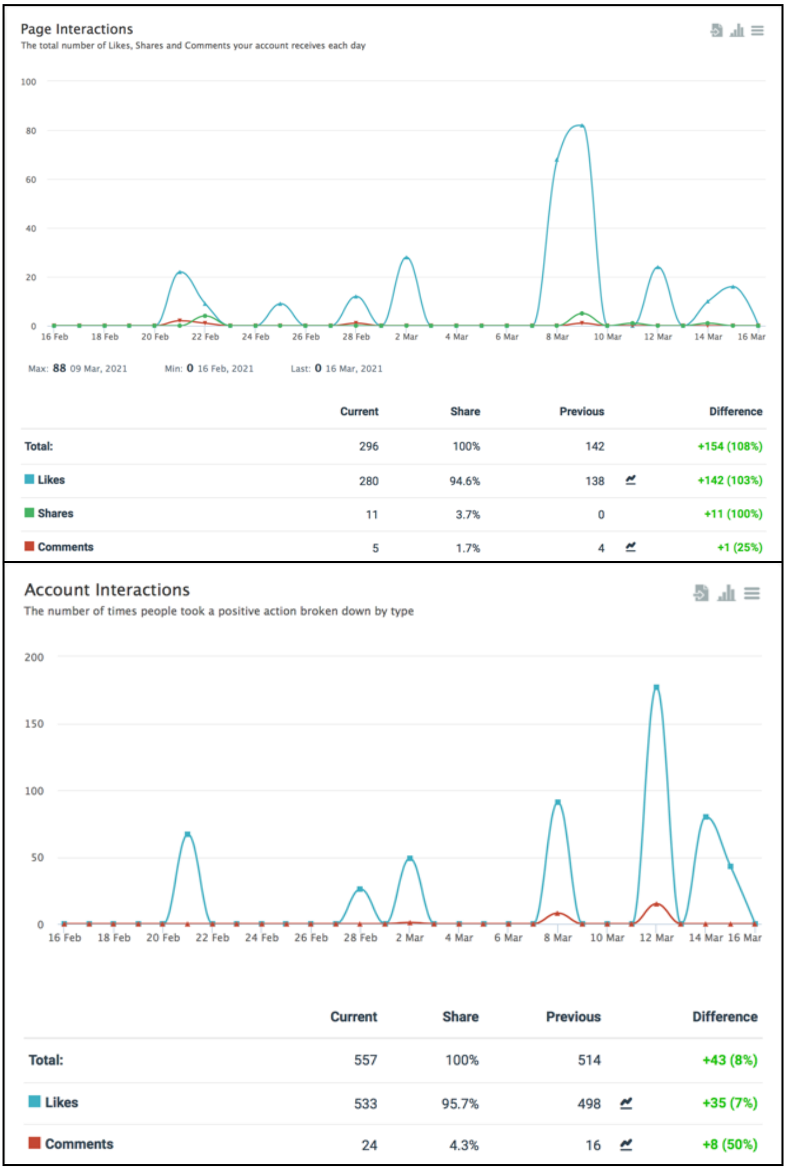

Figure 4. Interactions on Facebook and Instagram

Source: Zoomsphere.com analytics tool

In the survey conducted, which focused on the awareness and attitudes of the followers within the issue of sustainable fashion and its relevance in the current environmental situation, attitudes towards capsule wardrobe and relevant issues of the issue addressed, 270 respondents who are familiar with the Cila brand participated.
The results show the following facts:

- The brand's target group is predominantly women aged 25-34 who are either employed or students.
- Survey respondents are aware of the conditions of clothing production in Asia, so they predominantly shop at cheaper fashion chains, but this does not mean that they shop impulsively or recklessly when choosing new pieces of clothing for their wardrobe.
- They also like to go to second hand stores, where they can also find high quality clothes that will last for years for cheaper.
- They shop sporadically- local brands are mainly higher priced products, so they look for cheaper alternatives.
- If they decide to support a local designer and the local economy of Slovakia, they care not only about the price, design and quality of the products, but also about the concept, the story and the message that the brand spreads.
- They also pay attention to the certifications the company works with.
- In fashion, they are mostly inspired by Instagram, where they also inform themselves about the impact of the fashion industry and discover different alternative options for responsible and eco-friendly shopping behaviour.
- They are inspired by capsule wardrobes, they would like to reduce their wardrobe, give it structure and adapt it to their personality, but they need expert advice in putting it together.
- Most people when reducing their wardrobe, take their sorted clothes either to containers for charity or attend a SWAP event.

Customers also appreciate the direct contact with the brand, they like to try things on and therefore one of the solutions is to create a temporary shop. The trend towards ecology also helps the brand to become more visible on the market. Customers are interested in the topic, but the brand must not forget the importance of marketing communication in an offline or online environment.

In order to generate excitement and interest among the general public or fans of the Cila brand, the opening of a temporary store promotes the proposal of combining two brands that bring innovative and alternative ecological solutions, save space, do not create unnecessary emissions or minimize waste. Cila is a brand that promotes a capsule wardrobe philosophy, focusing on quality materials with timeless designs that are not dependent on current trends. In order to support the idea of Cila, a collaboration is being developed with the Slovak start-up Ecocapsule, whose space would serve as a temporary location for the brand.

Ecocapsule is a compact mobile home that allows its owners to live off the grid under specific conditions and in different locations. It is independent of public grids and infrastructure, can generate its own energy through solar and wind panels, and also filters captured rainwater. Currently, the Ecocapsule brand is looking for business partners who will provide it with beautiful locations around the world for the location of capsule rentals.

Figure 5. Ecocapsule
Source. https://www.ecocapsule.sk/#gallery

The essence of the collaboration is to bring together Ecocapsule and the capsule wardrobe theme, which share the common factor of sustainability. The capsule will be available to the general public and the curious. Inside, there will be a pop-up store (temporary shop) of the Cila brand and a presentation of the capsule wardrobe theme using the personality of the founder of the Cila brand herself.
Even in this innovative and technologically inexpensive, yet creative way, it is possible to communicate 21st century trends to eco-conscious consumers that will help do their part to save the planet.

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INNOVATIVE WORLD AND STANDARDIZATION 4.0

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Abstract

In previous years, more and more frequent changes in standardization can be noticed. Concurrently, standards cover more and more areas of human life. For this reason, it is essential to understand the purpose and importance of standardization for business, especially in the context of Industry 4.0. Therefore, some authors and organizations investigated the justification of such a trend of standardization.

The general conclusions are that the development of standards and their application leads to solving problems, e.g. compatibility, and has a significant impact on economic growth, e.g. enables, accelerates and reduces the costs of technology transfer and enables the market expansion of new technologies. The production of components and assembly of different products is possible in other places so that countries that did not have technological knowledge quickly joined the developed ones. In recent years, scientists have concluded that standardization has a significant impact on the creation and dissemination of innovation. The new theory claims that standards can influence technological change much earlier in the production cycle, mainly through the construction of positive return paths and by defining critical technological infrastructures and platforms on which various new products and services in Industry 4.0 can be built.

Keywords: *Standardization 4.0, Innovation, Quality infrastructure, Industry 4.0*

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1. INTRODUCTION

Organizations worldwide are cooperating with each other, to a greater or lesser extent. Modern standardization is a very active and widespread area. Business flexibility improves companies' ability to react quickly to customer requirements and increase production system productivity without incurring high costs and expending excessive resources (Fragapane et al., 2022). Therefore, it is vital to understand who the key participants are, how they influence each other, and business, economy, and society.

With the development of information and communication technologies in Industry 4.0, we have become a global society based on knowledge and information (Blind, 2011). However, to make Industry 4.0 an accomplishment, its processes and products must be standardized. That is the moment where Standardization 4.0 begins.

Today, most of the standards, which are the most common in an application, are adopted by consortia of leading companies and professional associations. Moreover, many of these standards are publicly available, and anyone with advanced knowledge in a specific field is invited to suggest changes and improvements (Blind & Mangelsdorf, 2012). Therefore, knowledge in the field of standardization is necessary for survival in the environment of Industry 4.0.

2. MODERN VIEW ON STANDARDIZATION IN THE CONTEXT OF INDUSTRY 4.0

Today, at the international, regional and national level, representatives of multinational organizations actively participate in many technical committees of formal standardization organizations. Of course, such a situation can lead to market monopolization and specific manipulations of dominant participants, but the principle of formal standardization at all levels is that everyone with knowledge and goodwill can cooperate in development (Blind, 2004; de Vries, 2006).

In developed economies, standards adopted by the state or state bodies usually have the status of the mandatory application (de Vries, 2008). Governments may include specific standards in the composition of regulations, or the regulation may refer to a standard. In such situations, the standard becomes mandatory, even though the standards are, as a rule, voluntary application (Blind, 2008).

Development of standards and their application, which leads to problem-solving, e.g. compatibility, has a significant impact on economic growth (e.g. enables, accelerates and reduces the costs of technology transfer and enables the expansion of the market of new technologies (Blind, 2004). According to Mijatović et al. (2014), products based on new technologies are falling apart in today's business environment, so many can afford and benefit from them. This chain - standardization, technological development, falling prices for products based on these technologies and increasing benefits for consumers - is the cause of growth in the global economy (Blind, 2011).

New technologies, such as digital, have introduced a modular concept into production - that many different products are made from the same components or modules (Shintaku et al., 2006). The production of components and modules and the assembly of various products is possible in different places. Therefore, countries that did not have technological knowledge quickly joined the developed ones (Shin et al., 2015). Manufacturers from Asian countries soon went from component manufacturers to active members of global consortia and standards development forums competing in the global marketplace. Today, the following motto can be heard: "whoever has a standard has a market" (Shin et al., 2015).

The number of participants in developing standards is higher today than ever before (ISO, 2015). As a result, a vast number of standards exist or are being developed (ISO, 2015). However, organizations cannot always cope and meet standards requirements for their product to appear on the market (Mijatović et al., 2014). For this reason, it is imperative to understand the role and importance of standardization for business and the relationship of standardization with related areas in the context of Industry 4.0.

3. BUILDING A QUALITY INFRASTRUCTURE IN THE CONTEXT OF INDUSTRY 4.0

The areas of conformity assessment, accreditation, metrology and standardization, which are components of quality infrastructure, play a role in the integrated technical mix necessary for a country to be able to trade successfully, both bilaterally and within the multilateral trading system (ISO, 2013).

3.1. The link between standardization, accreditation and certification in Industry 4.0.

As in the introductory part of this paper, we talked about the importance of standardization for the international market, and this relationship further confirms this attitude.

Because accreditation provides confidence in impartial and independent testing, calibration, or certification, it is essential in almost all industries and Industry 4.0 (ATS, 2015).

So, standardization organizations develop and publish standards that contain specific users' requirements. Accreditation institutions accredit conformity assessment organizations, which have the right to give certificates to organizations that prove their conformity with relevant standards (Pešaljević, 1995).

Jones & Hudson (1996) analyzed the impact of standardization on the well-being of users who rely on signals as indicators of product quality. With the reduction of tariffs and quotas in developed and developing countries over the last decades, international trade has increasingly occurred in global supply chains (Baldwin & Lopez-Gonzalez, 2015). The emergence of a supply chain, in which suppliers in one country produce semi-raw materials delivered to many countries, is enabled by

the global diffusion of international standards (Corbett et al., 2005) and current ethical standards (Prado & Woodside, 2015).
Developing countries increasingly use management system certifications to overcome reputation problems for entering international trade activities (Montiel et al., 2012). However, according to Maskus (2005), Clougherty (2014), Trienekens (2008) and Auriol (2015) and others, certification costs can be a barrier to trade, mainly because they are significant and usually higher in developing countries than in developed ones.
The ability of ISO standards certification to signal insignificant quality characteristics depends on the credibility of an institutional complex called "quality infrastructure" (Sanetra & Marban, 2007; Peuckert, 2014). Surprisingly, quality infrastructure institutions have largely ignored the empirical literature (Peuckert, 2014). In addition to national standardization and certification bodies, these institutions include metrological institutions and accreditation organizations, including their international associates (Peuckert, 2014).
Certification bodies can improve the reputation of their services if they are accredited by an internationally recognized accreditation body, which is a signatory to the IAF MLA arrangement (Blind et al., 2018).
According to a report by the World Trade Organization, mutual recognition of the accreditation system is an advanced form of building trust and cooperation, which reduces export costs (WTO, 2012).

3.2. The link between standardization and metrology in Industry 4.0.

Apart from the connection between standardization and accreditation and certification, the relationship between standardization and metrology is also complex. Namely, the metrological system measures units and means according to its basic orientation. At the same time, metrological regulations are defined in that system, and measuring instruments are tested. Measuring instruments are also products, so

standards are set for them in most cases (Pešaljević, 1995). Also, laboratories for their certification are being formed on that basis.
The same author emphasizes that standards are adopted following scientific and technological development, needs and requirements of society, organization or individual within standardization. Also, standards are adopted by the possibilities of achieving the required quality of output elements. Finally, the metrological system must perform measurements of standardized quality parameters of output elements per the adopted standards (Pešaljević, 1995).
For example, (Zhao et al., 2011) dimensional metrology is an integral part of any production system. It consists of various components and requires a large, diverse and interconnected knowledge base. Combining information with minimal cost and minimal data loss between the multiple components of a dimensional metrology system is a major issue for software and hardware manufacturers, standards development bodies and customers in Industry 4.0. According to Zhao et al. (2011). STEP ISO 10303 standards result from international efforts to achieve interoperability for production systems. Therefore, the extension of STEP is an appropriate way to solve the problem of interoperability within dimensional metrological systems.

3.3. The link between standardization and management systems of organization in Industry 4.0.

According to de Vries (2008), a quality management system involves developing, maintaining, and improving a quality management system compared to the product, maintenance, and improvement of standards. Second, the quality management system includes the development of procedures and guidelines, which can be considered as company standards (de Vries, 2008). For that reason, the theory of quality management can form a measure of the organization's standardization level.

Further, Dale & Oakland (1991) emphasize the importance of user participation. Users are involved in all relevant processes, supported by the standardization sector or the standards officer (de Vries, 1999). The primary focus should be to identify new opportunities within Industry 4.0 and make management systems sustained considering the new environment (Milosevic et al., 2021).

Modern standards of the quality management system (ISO 9000 series), among other things, contain requirements for quality management system in terms of organizational context, leadership, planning, support, implementation of operational activities, performance evaluation and improvement, according to Annex SL. They apply to all types of organizations, regardless of size (ISS, 2019) and product category: hardware, software, processed materials and services, industrial and economic areas and government and public sectors.

These standards refer to the goals that the system should meet but do not prescribe how these goals are achieved in individual organizations, leaving it to the organization's top management because they assume that each organization has its specifics. It is fascinating that, although some standards were built only to obey a single goal, they often do multiple functions (Rakić et al.,2021). Therefore, the application of these standards in Industry 4.0 may be helpful. However, by applying only the standards of the quality management system (ISO 9000 series), the desired effects and purpose cannot be achieved without using appropriate standards that define the technical characteristics of products and processes (Rakić, 2019).

The realization of planned goals is achieved by positioning the organization and continuous improvement of the process, developing and implementing effective and efficient strategies that improve process performance (Arsovski, 2002). Furthermore, the improvement of the process should meet the requirements set by all stakeholders in the modern world focused on innovation in new information and communication technologies (Industry 4.0).

New editions of standards ISO 9001: 2015, ISO 14001: 2015 and ISO 45001: 2018 introduce the concept of implementing operational activities, limiting the risk of non-conformity (ISS, 2019). Theoretically, the technological process should take place in the set conditions. Still, in reality, it is accompanied by numerous threats that, to some extent, lead to incompatibilities in achieving quality goals (Karkoszka, 2017). Therefore, it is necessary to manage the process performed by measuring the current values that describe the state of the process and the device to confirm the compatibility of the obtained values with the acceptance criteria. However, it should be considered that process management - the current interpretation of quality management - will slowly be replaced by integrated process management, within which management also covers environmental factors (Karkoszka, 2017).
The environmental management audit programs represent a way for organizations to improve their conformity with the environment and, in general, environmental performance (Evans et al., 2015).
The new ISO 45001: 2018 standard should support new areas of management systems, in line with Annex SL, to ensure better compatibility and better management of the system. In this way, implementing the system within the organization is more efficient (Kleinová & Szaryszová, 2014). The standard applies to all organizations wishing to establish and implement an occupational health and safety management system to eliminate or minimize risks to employees and other relevant parties. Furthermore, maintain and continuously improve health and safety performance, and maintain all operations following the stated health and safety policies of the given organization in Industry 4.0 (Karkoszka, 2017).

3.4. The link between standardization and intellectual property in Industry 4.0.

Blind and Thumm (2004) analyze the relationship between intellectual property rights protection strategies and their impact on the likelihood

of joining formal standardization processes. On the one hand, the theory suggests that the stronger the protection of one's technological knowledge, the more likely it is to join formal standardization processes to exploit the value of the technological portfolio. On the other hand, leading organizations often have a strong position, so they do not need the support of standards to successfully place their products on the market (Blind & Thumm, 2004).
Therefore, to encourage the development of new products, technical solutions, models or procedures that would be the basis of new standards, intellectual property rights must be considered in the context of Industry 4.0 (Acemoglu et al., 2012).

3.5. The link between standardization, education and public administration in Industry 4.0.

The standardization is connected with the business system, the education system and (conditionally called) the system of scientific research work. According to Pešaljević (1995), standardization provides the organization with the appropriate resources needed for its work and development and the necessary information. On the other hand, standardization helps the organization rationalize its work procedures. This knowledge can also be applied in the case of educational institutions (Rakić, 2019).
Standardization provides the education system with appropriate knowledge and requires the necessary human resources to ensure its work and development, and this is very important for Industry 4.0 processes and resources. In addition, there are numerous technical committees within the ISO organization for various fields, including ISO / IEC JTC 1 Information technology, which has developed and published 3297 standards, and 508 standards are currently under development (ISO, 2022). These data speak of the expansion of Industry 4.0 and the development of Standardization 4.0, bearing in mind that other committees number several tens or hundreds of standards, far less than the mentioned technical committee.

A study by Xie et al. (2016) clarifies how the search for knowledge relates to an organization's standardization efforts and more efficient innovation management. According to Nelson & Winter (1982), understanding how knowledge-seeking organizations help explain innovative behaviour is a perspective that has since been widely used in innovation discourse (Chiang & Hung, 2010). For example, Rosenkopf & Nerkar (2001) investigated how the local search for solutions, using current knowledge, opposes remote search or what Rosenkopf & Almeida (2003) call exploratory learning. Katila & Ahuja (2002) focused on search depth (how deeply existing knowledge is used) and search scope (how extensively new knowledge is explored), while Greve (2003) investigated complex searches caused by low performance and negligent search caused by excess resources.

There is also a connection between standardization and state administration systems. At the same time, the administration system defines specific strategic determinations of the work and development of the standardization system, controls their execution, and provides certain funds from the (state) budget needed to realize those determinations. If the connections of the observed systems are not established or do not function optimally, there are more or less pronounced disturbances in all systems (Rakić, 2019).

One of the main recognized goals of standardization is the protection of users by providing guarantees on the quality of products and services that will meet the intended purpose. The standards aim to promote compatibility, interoperability and quality (Xie et al., 2016). On the one hand, manufacturers and suppliers form a tandem that works closely together in standardization. At the same time, consumers and end-users are often excluded when drafting and adopting standards that can be overcome in Industry 4.0. The policy of invoking standards by administrative bodies implies that they fully recognize them and are involved in their adoption (Rakić, 2019).

4. INNOVATIVE EFFECTS OF STANDARDIZATION 4.0

It is commonly believed that standards hinder innovation, but the evidence says otherwise. Research by innovative organizations has shown that many organizations say standards are a source of information aided by innovative activities (Swann, 2010). Over time, scholars have argued that standardization has a significant impact on the creation and dissemination of innovation (Dolfsma & Seo, 2013; Wright et al., 2012).

In recent years, standardization processes have changed. The change is reflected in the fact that standardization used to be a process in which the market or organization chooses between different existing products, and today it is a process in which organizations pool their resources to jointly create new products and services, which is anticipatory standardization (Grøtnes, 2009).

Standards are one of many tools that can be used to foster interoperability among products or services. When they meet real market needs, they can help promote innovation, market growth, and investment assurance in new technologies (Shin et al., 2015). Standards can be a catalyst for innovation by encouraging organizations to contribute to standardization activities with their innovative technologies and share their intellectual property with others. In addition, standards developed and implemented through open and transparent processes successfully help create opportunities for product differentiation and promote more choices for users (Shin et al., 2015).

Standards can make a significant difference in innovation success by creating a common framework for innovation and establishing the game's rules. Hence, innovation is based on the industry's capacity and ability to do things more efficiently and simplify (Trajkovic and Milosevic, 2018). Standards establish frameworks by defining common vocabularies, defining basic characteristics of products or services, and identifying best practices within a system that will enable “full-fledged” results (Shin et al., 2015).

The CEN/TS 16555 standards provide detailed instructions for the innovation management system. Innovation management requires a different approach from managing other functions within the organization (Standard SRPS CEN/TS 16555-6). According to this standard, management activity should be limited to the support structure and mechanisms around innovation, not the innovation process itself. However, setting the most suitable conditions for people who have new ideas does not guarantee that they will bear fruit (Standard SRPS CEN/TS 16555-6). This standard emphasizes that ideas happen to people in different circumstances, for example, through a particular occasion, through hard work on a problem or while relaxing. Furthermore, ideas can also be generated from interactions with colleagues, clients, researchers and other interested parties. Wherever and what ideas happen should be written down or recorded not to be lost (Standard SRPS CEN/TS 16555-6).

The relationship between intellectual property and standards is an intensively considered topic as two mutually opposed areas discussed before (Shin et al., 2015). However, simply put, the standard is a tool for spreading innovation, and intellectual property is a tool for protecting innovation. For this reason, the link between standardization and intellectual property should be considered before reviewing the effects that standards have on innovation (Shin et al., 2015).

Blind & Thumm (2004) analyzed the probability of participating in standardization activities in organizations that own intellectual property rights such as patents and the like. Their analysis showed that organizations with more patents avoid participating in standardization to monopolize the market. Hence, there is a problem of a lack of technologies that can be chosen as a standard. For this reason, the authors of this study recommend forceful initiatives for such organizations to take part in standardization activities.

Standardization 4.0 provides better market access for innovative solutions and new technologies and thus increases the competitiveness of organizations (Sanjuan et al., 2011). Also, these authors claim that standardization contributes to environmental protection and helps

provide protection in terms of new technologies and cost savings as a significant Industry 4.0 side effect.
Standardization is networking with other researchers, industries, and interested parties such as suppliers, users, and regulators for future research and innovation projects (Sanjuan et al., 2011). Therefore, involving all those interested in shaping the essential rules for future research is also essential in Industry 4.0.

5. TECHNOLOGICAL EFFECTS OF STANDARDIZATION 4.0

According to Blind (2004), de facto (informal) standards are more ownership projects that occupy a dominant position in the market. Of course, the standards should be publicly available rather than a proprietary project. However, it cannot be denied that some industries have just developed on such standards. The emerging technologies in the Industry 4.0 era allow for new flexible production systems (Fragapane et al., 2022). However, Blind (2011) concludes that ownership standards provide a strong incentive for organizations to create new technologies superior to existing ones. Standardization supports competitiveness and competition in technology and market competition for all participants to achieve interoperability of complementary products and services or provide agreement on testing methods or requirements for organizational and other performance (Shin et al., 2015).

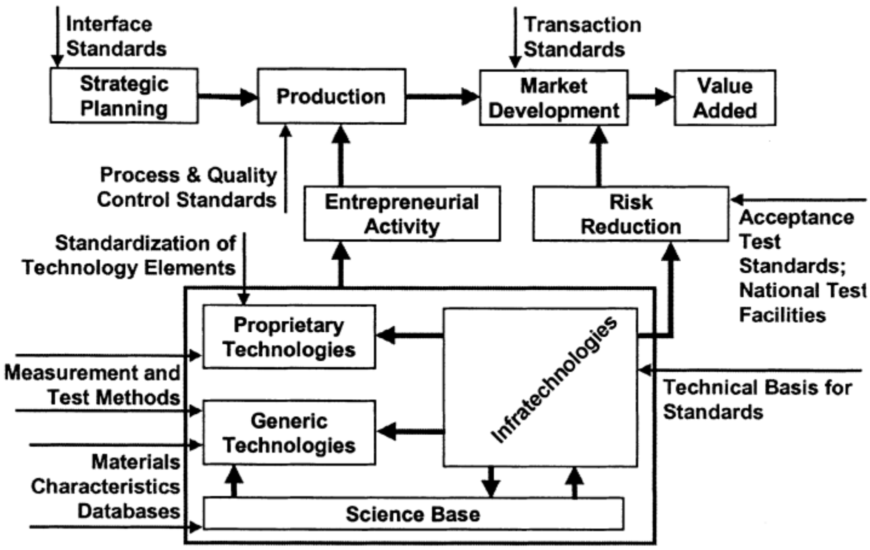

Figure 1. The role of standards in a technology-based industry (Tassey, 2000)

For Polo-Redondo & Cambra-Fierro (2008), process standardization reduces uncertainty for organizations that choose products and services. However, for these authors, the standards are not about standardizing the product itself but about systematic work and process management and guaranteeing certain quality levels.
In the early stages of new technology market development, standards can play an essential role in achieving focus and cohesion between "pioneer" organizations. However, as technologies can sometimes be "locked" because suppliers and users are deployed, there is no critical mass in the market development of such technologies (Blind, 2004).
In many high-tech industries, such as telecommunications and informatics, compatibility is increasingly exploiting potential economies of scale on the demand side, now known as external networks (Rosenberg, 1982). Standardization is a uniform way of achieving compatibility (Rosenberg, 1982). By choosing the same

interface or sharing the exact technical specifications in key components, products from different manufacturers can be combined and used harmoniously to exploit external networks (Choi, 1996). Standardization, however, is not without its costs, especially if the standards are set in the early stages of the technological cycle when the value of competing standards is not fully known (Choi, 1996).
The complexity of modern technologies, especially their systemic character, has led to an increase in the number and variety of standards that affect specific industries or markets. Technical standards are established norms or requirements applied to technical systems (Shin et al., 2015). Standards affect research and development, production, and the stages of market penetration of economic activity. They, therefore, have a significant collective effect on innovation, productivity, and market structure, as shown in Figure 1 (Tassey, 2000). Standards are classified into categories of production and non-production standards because these two types arise from different technologies and require different formulation and implementation strategies (Tassey, 2000). Moreover, since standards are a form of technical infrastructure, they have significant public good content. Further research must therefore include standardization in analyzes of technology-related issues (Tassey, 2000).
Technological standards have their specifics, especially in today's information and communication technologies environment - Industry 4.0, an important dimension. Organizations can often decide when is the best time to switch to new technology. Given the advantages and disadvantages of each standardization process, researchers often compare the characteristics of the two processes (ITtoolkit Magazine, 2018). Farrell & Saloner (1988) compared market standardization and formal standardization developed by technical committees and concluded that, although slower, committees-based standardization is much more efficient in coordination. Using a simulation model, Swann & Shurmer (1994) examined competition between a de facto standard produced on the market and a formal standard developed under the guidance of competent institutions. Belleflamme (2002) compares the

competition between the two standard-setting processes and the dynamic approach using the “Gender Struggle” coordination mechanism. However, the results of both studies depend on specific conditions, which leads to the conclusion that it is not possible to say that one standard-setting process is better than another.

6. CONCLUSION

Organizations have realized that it is not enough for researchers and innovators to generate a voluminous amount of new ideas. According to Swann (2000), when the rate of innovation is “excessive”, manufacturers cannot pay adequate attention to all user requirements. The results and processes of innovation must be successfully positioned in the market and disseminated for technological purposes. Researchers should recognize that standardization contributes to the dissemination of knowledge and scientific publications and patents since standards, among other things, are an essential part of the latest technology in science and application.

Shin et al. (2015) point out that the complexity of modern technologies, especially their systemic character, leads to an increase in the number and variety of standards that affect a particular industry or market, so Industry 4.0 as well.

It follows from the above that the spontaneous approach to Standardization 4.0 and its basic process of adopting standards carries the risk of reducing productivity and human life functionality. There is no clear link between the plan for adopting standards and economic activities.

However, for the excellent functioning of Standardization 4.0, more is needed than creative people, artificial intelligence, sophisticated knowledge, functional methods, equipment and processes. That is, above all, a sense of ethics because those who know what is good and do not practice “good” cannot build a sustainable “World of Standardization 4.0”.

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