Barriers to Implementing Industry 4.0 Technologies in the Business Environment

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Kľúčové slová: Priemysel 4.0, digitalizácia, MSP, bariéry, finančné prostriedky, Európska Únia

ABSTRACT

This bachelor thesis is focused on Industry 4.0 and its technologies, especially on the barriers of their implementation in small and medium-sized enterprises (SMEs) within Europe. This work aims to find out the biggest barrier of Industry 4.0 implementation for SMEs and determine the most important feature for Industry 4.0 implementation, as well as to analyse whether only large enterprises have possibilities to implement Industry 4.0, as it requires a lot of financial resources. Based on this assumption, we might predict that the inequality between large enterprises and SMEs in the context of Industry 4.0 could cause serious disadvantages for SMEs, and they might be driven out of the market by large enterprises. The need to examine this topic is because the attention of researchers is often given to large enterprises and further research focused on SMEs is necessary.

Keywords: Industry 4.0, digitisation, SMEs, barriers, financial resources, European Union

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I hereby declare that the print version of my Bachelor's thesis and the electronic version of my thesis deposited in the IS/STAG system are identical.

CONTENTS

INTRODUCTION

Nowadays, we live in the age of technology. The world and our way of living change so much faster compared to previous industrial revolutions. Every aspect of life is changing at an unprecedented pace – society, education, employment but especially production.

A brief summary of previous industrial revolutions should follow in order to point out what preceded the current situation.

The first industrial revolution, which started in the eighteenth century, gave rise to the idea of using water and steam for mechanisation. Hundred years later, electric power began to be used for mass production during the second industrial revolution. In the seventies of the twentieth century, the concept of automation was introduced as the result of the third industrial revolution.

Following these three milestones in human history, mankind witnessed the implementation of the technologies into production and the creation of a new reality of the fourth industrial revolution known for the Industry 4.0 technologies.

However, some people might consider this topic controversial and broad as it is still seen as a new concept. The novelty, still associated with this change, is the reason why further research needs to be conducted.

The main goal of this work is to determine the most significant barrier to implementing Industry 4.0 in small and medium-sized enterprises in Europe. Furthermore, the work explores the most crucial aspect for successful implementation and examines whether all companies have equal opportunities for Industry 4.0 implementation. The research is carried out under the assumption that small/medium-sized enterprises and large enterprises do not have the same conditions for implementation. Thus, small/medium-sized enterprises might be defeated by competitors represented by large enterprises. The aim of the work is also to find a possible solution for such a scenario.

While financial resources for the implementation of Industry 4.0 are undoubtedly essential, it begs the question of whether businesses of all sizes have equal opportunities and are ready for the change, which requires not only financial resources but also in-depth knowledge and awareness of precisely what is vital for the implementation of Industry 4.0.

Certain barriers and problems might occur while implementing Industry 4.0 technologies. First, this paper outlines the basics that encompass Industry 4.0 and explains the most important terms for its understanding.

As the focus is primarily on the European SMEs in the context of the business environment, categorising companies according to the classifying measures of enterprises based on the European Union's standards is explained as it is related to the main topic.

Prerequisites required for the implementation of Industry 4.0 technologies are briefly mentioned, including advantages and disadvantages resulting from the process of embracing this new trend.

The analysis examines barriers to implementing Industry 4.0 in small and medium-sized enterprises as they are interconnected within the businesses. Based on the analysis, the biggest barrier to the implementation of Industry 4.0 in SMEs is determined. The possible benefits of overcoming implementation barriers for SMEs are mentioned as well as a brief comparison of SMEs with large enterprises in the context of Industry 4.0 implementation.

As the paper's main focus is on enterprises within Europe, the financial support of the European Union for SMEs in the context of Industry 4.0 is assessed together with other possibilities of support provided by different entities.

Based on the current state of Industry 4.0 implementation, it can seem that only big corporations have the means to implement these advanced technologies because it requires substantial resources, not only of financial character. Possible problems that might occur in association with this issue are unequal competition and serious disadvantages of small/medium-sized businesses in comparison to large businesses.

The biggest barrier of Industry 4.0 implementation for SMEs is stated in conclusion alongside the most important feature for successful implementation.

This work aims to conclude whether the initial statement, which claims that only large enterprises have possibilities to implement Industry 4.0 as it requires a lot of financial resources, together with the prediction that the inequality between large enterprises and SMEs in the context of Industry 4.0 will cause severe disadvantages of SMEs, was correct or not.

I. THEORY

1 BASIC CONCEPTS OF INDUSTRY 4.0 TECHNOLOGIES

The following sub-chapters introduce basic terms and key concepts of Industry 4.0. Topics such as Industry 4.0, smart factories, and cybersecurity are described as well as their importance in relation to the fourth industrial revolution is outlined.

1.1 Industry 4.0

As claimed by Rojko (2017, 80), the rapid development of Information and Communications technologies at the beginning of the 21st century marked the beginning of the fourth industrial revolution. Industry 4.0, which is according to Kumar and Nayyar (2020, 1) also called "smart manufacturing" or "industrial internet," could be explained as a strategic initiative emerging from the need for transformation of global production capabilities. (Rojko 2017, 80)

The digitisation that is often mentioned in relation to Industry 4.0, Horváth and Szabó (2019, 124) consider as a sub-concept of Industry 4.0. Digitisation means a shift from automation to a self-organising cyber-physical production system, which results in the flexibility of quantity and customisation of mass production. (Rojko 2017, 80)

As stated by Abraham et al. (2020, 1), the key aspects of Industry 4.0 are automation, implementation of advanced technologies in manufacturing processes, data exchange which requires permanent connection of machines that are able to work independently of human assistance. According to Vaidya et al. (2018, 236), such implementation means the use of Cyber-physical systems, which are interconnected and intelligent. The goal of this process is the automation of all phases from design and manufacturing to supply chain and maintenance. (Rojko 2017, 82)

In the opinion of (Rojko 2017, 88), the purpose of the integration of Industry 4.0 is a transformation of industrial manufacturing through the utilisation and digitisation of new technologies. The result of globalisation which encourages global competition, is a requirement for sufficiently agile production in order to satisfy market needs. (Rojko 2017, 77; Schwab 2016, 32) According to Rojko (2017, 77), this purpose can be fulfilled by implementing Industry 4.0 technologies in manufacturing processes as well as in the company's value chains.

The aforementioned integration process requires the transformation of factories to smart factories where connectivity and interoperability are crucial for successful Industry 4.0 implementation. (Rojko 2017, 82) However, Industry 4.0 is not only a technological but also a socio-economic phenomenon. (Horváth and Szabó 2019, 119). As can be seen,

authors differ in naming what is defined as Industry 4.0; however, the main definitions revolve around the same concept – technological advancement enabling interoperability and the connectivity of the industry.

1.2 Smart factories

As stated by Kumar and Nayyar (2020, 6), smart factories are the main pillar of Industry 4.0. The first step in the development of smart factories was the production of only one product that was performed by production lines consisting of machines that had specifically defined tasks. With further improvement, new possibilities were explored, such as wide production of different products. Currently, modern CNC machines are capable of flexible manufacturing. Quantity, as well as a type of products, is adjustable, which enables manufacturers to meet the requirements of a rapidly changing market. (Rojko 2017, 81)

Cyber-physical systems are basic building blocks of smart factories whose main characteristics are decentralisation and autonomy. These systems connect features of physical space with cyberspace resulting in the integration of components of Information and Communications technologies with physical systems. (Rojko 2017, 77) Cyber-physical systems are combined and applied together with the Internet of things into the process of production in order to transmit and gather information. (Kumar and Nayyar 2020, 2) Kumar and Nayyar (2020, 6) explain that Cyber-physical systems communicate via the Internet of things.

As reported by Mařík (2016, 26), advanced connectivity enables the collection and exchange of real-time information linked to all aspects related to the processes of production. As already mentioned, Cyber-physical systems are autonomous, which means they are able to make calculated decisions that are influenced by analysing results of past actions and learning from them while using real-time data and algorithms. (Vaidya et al. 2018, 236; Rojko 2017, 81) As claimed by Kumar and Nayyar (2020, 2), Enterprise Resource Planning and Manufacturing Execution Systems are providers of software control in smart factories, which is decentralised.

Machines that are used in smart factories also include already mentioned CNC or NC machines which are programmable. M2M – machine-to-machine as well as H2M – human-to-machine interaction needs permanent Wi-Fi connection. (Rojko 2017, 81)

According to Vaidya et al. (2018, 235), the advantage of advanced interaction between machines and permanent connection is enabled via the industrial Internet of things which is

an interconnected worldwide network that is regulated by certain protocols. As claimed by Kumar and Nayyar (2020, 6), the industrial Internet of things is a subset of the Internet of things.

Rojko (2017, 82) claims that human-to-machine interaction is also important in smart factories, as certain tasks cannot be fully automated. However, it could still be seen as a considerable improvement since these tasks used to be performed fully manually before. Machines are able to interact with humans and learn from them. Products made by smart factories can be smart as well. They have sensors that serve for localisation and monitoring not only the production process but also the life cycle that makes maintenance significantly easier.

The business activity that coordinates the process of production in smart factories is called Product Lifecycle Management which effectively supervises and controls the whole lifecycle of products from the idea of a product until its retirement. It can be considered as one of the most relevant parts of smart factories since it helps to make an expected profit, brings satisfaction to customers, whereas a company is defined by its products, and also protects the health of workers. However, the implementation of product lifecycle management is challenging. It includes everything related to the life of the product, which includes organisational structures, people, product data, various processes, etc. (Stark 2016, 5-7)

1.2.1 Big Data and Cloud

Big data and cloud are inherent parts of Industry 4.0. As mentioned by Rojko (2017, 82), machines in smart factories have the capability of learning and real-time interaction with the environment. They do not consist only of their physical representation, but they also have their virtual identity, which is stored in the data cloud. The process of constant data exchange is supported by connecting Cyber-physical systems with the help of cloud systems. As stated by Kumar and Nayyar (2020, 2), the cloud is used for the storage of collected data. The combination of the Internet of things and big data analytics supports the integration of the physical and digital world. Collection and analysis of data enable making real-time decisions and notice threats. Such a process enhances the production as errors are minimised. (Vaidya et al. 2018, 234)

The existence of geographically separated data centres that are available worldwide represents an opportunity for productivity growth and optimisation in companies of all sizes. Building own clouds - data and computing centres is costly. (Mařík 2016, 54)

1.2.2 Progressive manufacturing technologies

Industry 4.0 may be a broad topic, and according to Kumar and Nayyar (2020, 1), it certainly includes a wide range of new technologies. Some of the most relevant are introduced.

Schwab (2016, 20) characterises additive manufacturing, also called 3D printing, as a technology that creates physical objects based on a digital 3D model by printing layer upon layer into a three-dimensional shape. The advantage of additive manufacturing is its easy customisation. According to Horn and Harrysson (2012, 255), the mentioned process is widely used to rapidly prototyping parts before mass manufacture. It is considered to be a cheap option of low-volume production of high-quality at a reasonable cost. (Vaidya et al. 2018, 236; Horn and Harrysson 2012, 258)

Another technology that belongs to progressive manufacturing technologies is augmented reality. Volker (2014, 1) characterises augmented reality as "the integration of additional computer-generated information into a real-world environment." Such information can be generated as graphics that are integrated into the current surroundings of the viewer. In a rapidly changing environment, augmented reality supports workers by guiding them through unfamiliar tasks in real-time. (Volker 2014, 1)

One of the more advanced technological developments that are starting to emerge as a potentially powerful addition to the manufacturing process is Artificial Intelligence. As stated by Goel and Gupta (2020, 157), a process in which a machine or computer can perform actions comparable to those of human beings is called Artificial Intelligence. Artificial Intelligence means that systems have the ability of human behaviour due to knowledge. (Goel and Gupta 2020, 158)

However, if one wants to look at the currently employed advanced technologies, robots and their role in the automated manufacturing process cannot be overlooked. The use of robots in production varies, as several types of robots in different industrial sectors can be used. The functions of robots develop together with Industry 4.0, and they have many abilities, such as office management, logistics, or production, to name a few. (Goel and Gupta 2020, 160) As Lamon et al. (2020, 9128) claimed, palletising robots have a strong influence on the amount of output and time of production. Heavy robotic arms are able to lift up to a thousand kilos. However, in some sectors, human assistance with robots is still required. Robots that are able to cooperate with humans without endangering their health are called cobots. Collaborative robots are flexible and able to learn various tasks. Another solution is humanoid robots.

Autonomous robots are already being used in mass production. They constitute means to increase productivity, increase production quality and save on human resources. (Mařík 2016, 52) However, industrial robots are considerably expensive, especially from the standpoint of SMEs. Cobots that are easy to program and have lower weight are more affordable for SMEs. (Goel and Gupta 2020, 160)

1.2.3 Horizontal and Vertical Integration

According to Kumar and Nayyar (2020, 7,12), effective communication within a company is achieved via horizontal and vertical system integration of data in order to secure the interconnection of machines, products, and materials. Vertical integration means digitisation of production, supply chain, quality, logistics, operations, and product life cycle management. Under the term, horizontal digitisation falls the data integration with key partners, suppliers, and customers. A digital ecosystem is created by integrating vertical and horizontal digitisation, where everything operates smoothly due to data flow.

1.2.4 Cybersecurity

Since everything in smart factories is interconnected via the industrial Internet of things, another important problem that needs to be considered is the storage of this big amount of data that requires cybersecurity to protect the know-how of the company. Cybersecurity in manufacturing means integrity, confidentiality, and availability of data. Companies should be focused on building cybersecurity policies. Cyber-attacks, which occurrence grows exponentially, make manufacturing systems vulnerable and can cause serious problems in the business models of corporations and can have many negative impacts such as malfunctions of machines, crashes of the network, production shutdowns, thefts of intellectual property, putting lives of workers in danger and many others. (Corallo et al. 2020, 2-3)

1.3 Categorisation of small and medium-sized enterprises (SMEs)

Having described the main topics involved with Industry 4.0 briefly, it is also important to introduce small and medium-sized enterprises (SMEs) to comprehend their ties and interactions with new technological trends.

According to the European Commission, the main criteria for defining SMEs are the number of employees, which is presented in Table 1 as the staff headcount and turnover or balance sheet total. These criteria apply only to individual companies. (Europa.Eu 2016b)

Table 1 shows that small enterprises have less than 50 employees and turnover lower or equal to 10 million euros, while medium-sized enterprises have less than 250 employees and turnover lower or equal to 50 million euros, or balance sheet total equal to or lower than 43 million euros.

Table 1 Categorisation of SMEs (Europa.Eu 2016b)

Company category	**Staff headcount**	**Turnover**	or	**Balance sheet total**
Medium-sized	< 250	≤ € 50 m		≤ € 43 m
Small	< 50	≤ € 10 m		≤ € 10 m
Micro	< 10	≤ € 2 m		≤ € 2 m

2 IMPLEMENTATION OF INDUSTRY 4.0

As mentioned by Horváth and Szabó (2019, 126) and Abraham et al. (2020, 1), the necessity to implement Industry 4.0 in companies emerges because its importance in overcoming competition will be crucial. Vaidya et al. (2018, 233) claim that implementation of Industry 4.0 does not mean only the change of production, but it is connected to the entire value chain – all its functions and services.

According to Rojko (2017, 84), it is quite likely that companies might want to implement Industry 4.0 technologies while using existing resources. The need to create a precise way to transform available technologies and equipment to achieve the accommodation of this new concept emerges.

In preparation for the implementation of Industry 4.0, an accurate interpretation of the concept is vital in order to set up goals and decide about further developments. (Horváth and Szabó 2019, 124) Both Horváth and Szabó (2019, 124) and Adamik and Nowicki (2020, 27) bring to attention that a common way of thinking and understanding within a company is essential.

Rojko (2017, 86) claims that attention needs to be paid to the fact that even though companies might be willing to implement Industry 4.0 technologies, they want to maintain uninterrupted production during the transition phase. Such a process is time-consuming; therefore, the possibilities of incremental investments are important.

As stated by Agostini and Nosella (2019, 625-626), investments are necessary for both information and communications technologies and advanced manufacturing technologies. Advanced manufacturing technologies are computer-assisted technologies with the possibilities to adopt Cyber-physical systems and be involved in manufacturing activities. Integration of Industry 4.0 does not depend only on advanced manufacturing technologies but also on organisation, IT competencies, and management with a strategic vision.

As reported by Mařík (2016, 38), five levels of digital development in the enterprises exist:

1. At the first level, the company has an established information system for production management, but its Internet presence is passive. The company is beginning to consider the digitisation of processes, production, maintenance, etc. However, it does not have a defined digital strategy. It is able to at least partially participate in information flows

within the relationship between supplier and customer. Basic economic software enables communication with other state administration institutions.

2. An interactive web presence, the company is software controlled and begins to understand the importance of data. The first integration projects and automation are being implemented. Consideration is being given to setting up a digital strategy and involvement in information flows of supply and demand chains, such as interactive digital catalogues, semi-automatic orders, etc.
3. The third level involves the presence of multiple channels (web, mobile, tablets, social networks) within the company. The company has a defined digital strategy and data culture foundations - data culture integration projects, real-time integrated automation, personalised products with virtual components.
4. The next level can be characterised by the integrated multichannel presence in the digital world as well as by distributed and personalised digital strategy in the company. The data architecture is integrated throughout the production chain from communication and data sharing from the customer to the subcontractor. Digital diagnostics is used to predict faults and problems in the system.
5. The company is a digitisation platform connecting the online and offline world into one fully integrated and economically efficient unit. It offers a unique personalised experience to its customers through virtual products that communicate with customers throughout the life cycle. The latest and most effective approaches (full automation, 3D printing, etc.) implement a cybernetic system capable of individualised implementation of the physical part of the product. The company globally manages the production domain space. (Mařík 2016, 38)

As reported by Rojko (2017, 86-87), the preparedness of enterprises for this undertaking can be evaluated based on various levels, that can be observed in Table 2, from the strategy and organisation through smart factories, their operation, and products to human resources. The survey that categorised 268 German companies indicated that 56.5% of enterprises do not meet the requirements of Industry 4.0 implementation at all levels. 20.1% were partly ready for the process of implementation at the beginner level 1. Only 0.3% were evaluated as top performers meeting all dimensions of implementation at level 5.

Table 2 Levels of Implementation (Nayyar and Kumar 2020)

Level	**Designation**
0	Outsider
1	Beginner
2	Intermediate
3	Experienced
4	Expert
5	Top Performer

A survey assessing the readiness of businesses for Industry 4.0 has been conducted. Nineteen countries and 1,500 C-level executives (CXOs) were involved. Only 14% of respondents claimed that they are highly confident to handle the challenges of Industry 4.0, and about 20% CXOs admitted the preparedness of their companies for a new business model. Barely 25% of respondents believed that their employees have sufficient knowledge to implement Industry 4.0 successfully, and 84% were trying to create a well-educated workforce admitting that radical changes are necessary. Less than 15% agreed with the fact that they are well-prepared for smart and autonomous technologies. (Renjen 2018, 9-11)

2.1 Advantages and Disadvantages of Implementation

Before considering barriers to implementing Industry 4.0 technologies, advantages, as well as disadvantages, need to be taken into consideration. To a non-involved reader, not all of these aspects may seem to be clear initially, so there is a need to sufficiently clarify and describe the ups and downs of Industry 4.0 implementation. Even though it may seem that application of Industry 4.0 concepts will only have a positive impact on the company's manufacturing capabilities and productivity, not to mention profit growth, there certainly are also downsides and barriers that need to be overcome if one wants to fully utilise the benefits of these modern technologies.

2.1.1 Production and costs

According to Rojko (2017, 80), the biggest advantage of Industry 4.0 implementation is a highly efficient and quality mass production with approximately 10-30% lower costs resulting from just in time production, including saving costs ascribed to storage. Another benefit is a decrease in logistic and quality management costs by 10-30%.

Corallo et al. (2020, 2-3) highlight the benefit of effective use of natural resources and energy with an increase in labour productivity which results in lowering the environmental

damage while efficiency is improved from 15 to 20%. That enables the faster development of the product from the idea to its availability for customers.

Industry 4.0 is focused on innovative methods of industrial production and secures stable economic growth. (Popkova et al. 2019, 4)

2.1.2 Automation and Big Data

Permanent connection and exchange of real-time information can be considered as an advantage of Industry 4.0. However, the enormous amount of information is not a burden only with respect to storage but also for human employees who need to make decisions in real-time based on them. It is a great responsibility because the mentioned decision-making process is too complex and has an impact on stakeholders. It might be more challenging for workers to see the bigger picture. (Sniderman et al. 2018, 28-29)

Another disadvantage is automation bias which is responsible for the fact that workers might have a tendency to accept answers of machines as correct, even if it is conflicting with their own instincts. (Sniderman et al. 2018, 28) According to Guszcza (2018, 40), the paradox of automation might occur because people rely more on technology. However, in case of a problem or failure, workers are not prepared to handle the problem by themselves. Algorithms and users need to have a sufficient understanding in order to cooperate effectively. (Guszcza 2018, 42) Moreover, constant alarms and alerts of machines can also cause employees' resistance, and more likely happens that serious problems might be ignored. (Sniderman et al. 2018, 29)

A study conducted in the United States reveals that organisations spend approximately 21,000 hours and 1.3 million dollars annually to investigate error security alerts. Automation could save these costs and time as certain tasks are too complex for humans, and it could also prevent accidents. (Golden and Johnson 2018, 51)

2.1.3 Employment and Economy

An advantage of implementing Industry 4.0 technologies in the companies enables the reduction of employees; in some cases, the need for human labour is reduced ten-fold. (Schwab 2016, 14) Companies might prefer to substitute the labour cost for an increase in company capital. (Schwab 2016, 16)

However, this results in unemployment, lower wages, thus – lower consumption. On the other hand, consumers gain the most due to the implementation of Industry 4.0 since they can consume more goods and services for a lower price and higher quality. (Schwab 2016, 32)

According to Schwab (2016, 32), Industry 4.0 will have a great impact on the global economy. Focusing on the positive side of Industry 4.0 implementation, it will cause economic growth. However, the fourth industrial revolution creates a significantly lower amount of jobs in new industries than in previous revolutions, resulting in a negative impact on the labour market. (Schwab 2016, 37) Another scenario might occur as well - if companies do not need a competitive advantage of low-cost labour any longer, they move from developing countries to advanced economies. Such a process would have an impact on the global economy. (Schwab 2016, 48)

Another point that is important to mention in the context of employment is the emergence of new types of employment, which do not necessarily have to be understood positively. It includes remote work, contract work, gig economy workers, to name a few. It was observed in practice that these workers do not have real bonds with other co-workers or leaders, and they have a less mutual trust that results in image creation as less competent and reliable. (Sniderman et al. 2018, 28)

As stated by Golden and Johnson (2018, 47), the need for cybersecurity has created a large number of job opportunities for experts in this field. However, zero unemployment in an industry is not necessarily positive and can cause salary inflation, mismatches between workers, and high turnover.

On the other hand, the implementation of Industry 4.0 brings a great advantage for low qualified workers because they can start their employment faster as the cooperation with machines is enabled due to technological guidance. (Müller, Buliga and Voigt, 2018, 8-9)

2.1.4 Excessive connection

Some companies indicate that excessive sharing of information with suppliers and customers can be detrimental because they can access real-time information about the company. Other companies see a real-time connection as something beneficial and pursue connectivity. Inter-company connectivity brings advantages such as wider customer reach, easier communication, payments, optimisation, etc. However, enterprises should share data with stakeholders in a way beneficial for all partners within the supply chain as the content of shared information is sensitive. Mentioned problem is related to cybersecurity and requires new legal and ethical approaches. (Müller, Buliga and Voigt 2018, 8)

II. ANALYSIS

3 BARRIERS TO IMPLEMENTING INDUSTRY 4.0 TECHNOLOGIES IN SMEs

The following subchapters evaluate barriers to implementing Industry 4.0 in small and medium-sized enterprises. As barriers and stimulations to implement new technologies are, according to Adamik and Nowicki (2020, 17) interconnected, possible benefits of overcoming implementation barriers for SMEs will be mentioned as well. The last subchapter deals with the comparison of SMEs with large businesses in the context of Industry 4.0.

3.1 Barriers of SMEs

Small and medium-sized enterprises (SMEs) form a substantial part of the economy of some countries and add a share of the gross value of over 50% of the European economy. (Müller, Buliga and Voigt, 2018, 3)

In the opinion of Orzes et al. (2018, 1348), it is likely that SMEs will have the greatest difficulties implementing Industry 4.0 due to insufficient resources. This statement is also supported by Agostini and Nosella (2019, 626) by claiming that integration of Industry 4.0 is challenging for SMEs as it requires major investments in advanced manufacturing technologies.

Based on the research of Horváth and Szabó (2019, 119), which presents statements of SMEs, the biggest challenges to implementing Industry 4.0 technologies are limited financial resources, lack of skilled workforce, and insufficient cybersecurity. Authors also, claim in general, that SMEs are less prepared to implement Industry 4.0 technologies. (Horváth and Szabó 2019, 122)

As claimed by Orzes et al. (2018, 1350), barriers to implementing Industry 4.0 can be divided into six main categories:

The first category includes economic or financial barriers. In a study focused on 37 SMEs from different countries, including Austria and Italy, the majority of participants indicated that the most challenging factor to implementing Industry 4.0 is a lack of financial resources. Enterprises also pointed out various challenges that fall into this category, in particular a long process of implementation that can result in interrupted production, high costs, and unsure return on investment. Among other challenges belong to cultural barriers related to problems with cooperation within departments. Focus groups claimed that lack of competence and education also results in fear of losing jobs and that employees do not have sufficient knowledge of Industry 4.0. Legal and technical obstacles

and difficulties of an implementation process were taken into consideration as well. (Orzes et al. 2018, 1348)

3.1.1 Financial resources and competition

Research conducted in Germany by Müller, Buliga, and Voigt (2018, 6), which involved 68 SMEs categorised based on the staff below 500 employees and annual turnover below 50 million euros, revealed the opinion of owners of these enterprises that digitisation is on the level of infancy in SMEs and nature of Industry 4.0 depends on the size of the company implementing it. Organisational efforts required for implementation were addressed as challenging, as well as high investments in machines, IT infrastructure, technical training, and cost for IT personnel. Another problem that interviewees pointed out is expensive implementation requiring further expenditures. However, the willingness of customers to pay does not proportionally increase. The implementation process is too complex, machines have various degrees of automation, and if there is a malfunction of one machine, an entire production might be affected. The SMEs expressed the lack of expertise and need for external assistance provided by the government or the trade community. Interviewees claimed that if they do not implement Industry 4.0, they will be driven out of the market by advanced competitors and lose their customers. (Müller, Buliga and Voigt, 2018, 6) Agostini and Nosella (2019, 627) stated that SMEs need more support to integrate Industry 4.0 than large companies.

Due to higher financial resources, multinational enterprises have better opportunities to implement and invest in Industry 4.0 technologies. Thus, they have a more advanced production and competitive advantage over SMEs. SMEs have not only a lack of financial resources but also capacity constraints which is a significant limitation for development opportunities. Lack of financial resources also affects experience and possibilities of conducting research projects. SMEs possess weaker networks and fewer suppliers. (Horváth and Szabó 2019, 122)

3.1.2 Conservative investment strategy

It is difficult for SMEs to assess the performance and preparedness for Industry 4.0 because of a lack of real-time, consistent, and accurate information. Even though SMEs comprehend the possibility of long-term benefits of implementing Industry 4.0 technologies, they have an aversion towards costs related to that. Mentioned costs include the purchase of new machines, integration of Cyber-physical systems, sensors, soft-wares, and an upgrade of existing machines. SMEs want to avoid the risk of investing in wrong

technologies, and fear of the unknown might be experienced as well. The identification of the right technologies for implementation is challenging and requires highly skilled employees and managers. SMEs require government support in that matter. (Müller, Buliga and Voigt, 2018, 8)

3.1.3 Workforce and management proficiency

According to Horváth and Szabó (2019, 119), Industry 4.0 will have a great impact on the labour market and society. Müller, Buliga, and Voigt (2018, 8) admit that due to the lower level of automation in SMEs, these companies depend on their manufacturing employees to a greater extent than large companies. Mentioned fact necessitates a substantial training of employees in SMEs because of the need for human interventions in case of occurrence of machine failures. Businesses are beginning to demand college-level education of their employees who need to face diverse responsibilities and whose training and relocation might become more common.

According to Horváth and Szabó (2019, 122), lack of knowledge of SMEs' workforce causes lower manufacturing flexibility. Flexibility brings the ability to respond to the needs of customers. Thus, high quality of services is defined as a basic condition to participate in market competition. (Horváth and Szabó 2019, 127)

However, Müller, Buliga, and Voigt (2018, 8), taking into consideration the amount of workforce found out, that fewer workers experienced in manufacturing are required due to Cyber-physical systems which could potentially mean lower costs for enterprises.

On the contrary, Industry 4.0 increases the need for experts in IT and, as it was mentioned by Müller, Buliga, and Voigt (2018, 8), people with higher education. Those experts would require more money for their job performance, which could potentially cause an increase in costs.

As a result of digitisation, businesses need leaders with experience and appropriate skills to control Industry 4.0 projects. The lack of such leaders is a problem mostly in small businesses. Detail project planning needs to be conscious and includes specific goals and the use of resources. Successful implementation of Industry 4.0 requires a great structure and organisation. Without proper flexibility and optimisation of processes, the implementation of new technologies might fail. Adequate management and organisation are crucial. (Horváth and Szabó 2019, 126-127)

Figure 1 depicts that rather than financial resources, the lack of a skilled workforce is the biggest barrier for SMEs in all industries.

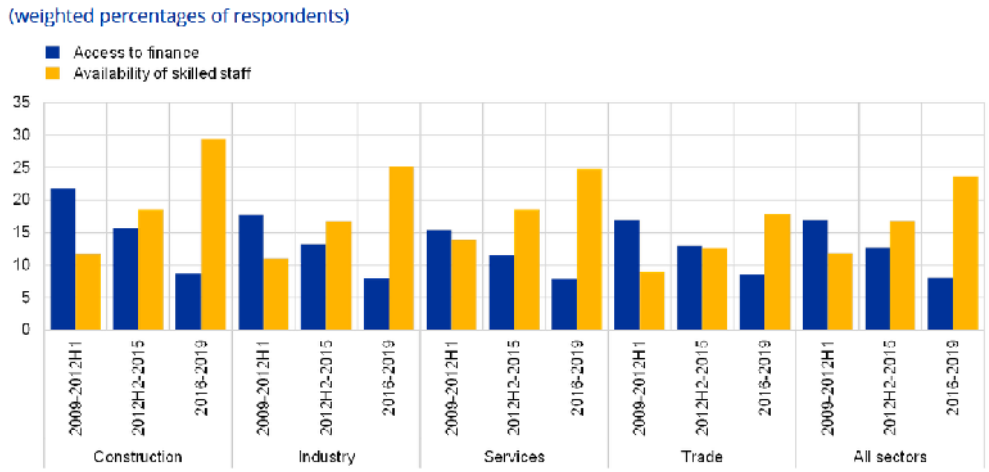

Figure 1 Most significant problems faced by euro area SMEs across sectors (Bańkowska, Ferrando and Garcia, 2020)

3.1.4 Big Data and Cloud

As claimed by Sharma and Pandey (2020, 63), a possible threat of big data is setbacks which can have a negative influence on small-scale industries. Thus, it needs to be taken into consideration as a barrier to implementation. Another fact supporting the statement of inequality of enterprises in the context of Industry 4.0 implementation is the challenging reality for SMEs, which requires competing with large industries operating with big data and with the ability to use them for various operations. It becomes challenging for small companies to survive in the market as their resources are limited.

Disadvantages related to big data are not involved only in the technical side of Industry 4.0 but also in the education of human labour. Big data analysis requires people who have an excellent knowledge of mathematics and information technology. Scarcity of specialists and the fact that requirements for mentioned specialists grow 13-23% per year might be considered as another challenge. (Mařík 2016, 51)

As regards the protection of data, the Internet network has a transnational character, but data protection and data rights regulations are not comprehensive. In Europe, regulations related to the protection of personal data exist, but they are not sufficient in many other jurisdictions; thus, it can be considered as a barrier to the successful implementation of Industry 4.0 technologies as well. (Schwab 2016, 70)

3.1.5 Willingness and motivation

Müller, Buliga, and Voigt (2018, 9) describe two roles for SMEs related to Industry 4.0 – users and providers. Enterprises considered to be users implement Cyber-physical systems

solutions. Providers manufacture mentioned solutions. There are two motives of companies to implement Industry 4.0. First, internal ones that are derived from market opportunities. They are proactive and cooperate with supply chain partners and universities by conducting research projects. Second, externally motivated enterprises that focus on Industry 4.0 as on pressure, not as an opportunity, and implement it as it is required by the demand of large customers. In the research conducted in cooperation with 68 German SMEs, the first group of enterprises expressed unwillingness to make any changes towards Industry 4.0. The second group claimed that they need a lot of time to implement new technologies, some of them up to 15 years. The third group envisioned the usage of Industry 4.0 and agreed that new technologies are vital as they do not want to be driven out of the market. The last group with a high-automation degree viewed Industry 4.0 as an opportunity to become industry leaders. (Müller, Buliga and Voigt 2018, 9)

Furthermore, it was confirmed by Horváth and Szabó (2019, 126, 128) that the implementation of new technologies is expensive, and it is the biggest challenge for small businesses. However, SMEs cannot be competitive and cannot cooperate with partners without digitisation. Another complication to implementing Industry 4.0 is a lack of technological standards, process standardisation, and willingness to cooperate within the supply chain.

3.1.6 Social capital and investments

As cooperation between businesses has been briefly mentioned, attention needs to be paid to the social context. Agostini and Nosella (2019, 628) outline the social capital, which can be divided into an internal and external one. Internal social capital represents the relationships of employees within the individual company and expresses the level of collaboration. External social capital depicts connection and cooperation with other external businesses and institutions. Social context is crucial for Industry 4.0 implementation. The success of implementing Industry 4.0 relies on the willingness and strong management approach to establish social connections. Social setting and new organisation of work are key elements as well as collaboration with other parties of the market, technology and infrastructure providers, etc.

The past research was highlighted by Agostini and Nosella (2019, 629), which proved that a fundamental factor for the integration of new technologies is management support. Management is also responsible for further use of obtained grants and financial support.

Thus, it can be logically assumed that social context is one of the key elements of Industry 4.0 implementation as obtaining financial assistance without a desire and effort to implement new technologies is worthless.

Agostini and Nosella (2019, 630) describe another barrier partially related to the social context. It is the lack of absorptive capacity which is necessary in order to make good use of investments. It represents the ability to integrate knowledge and build communicative infrastructure with the purpose of improvement. In other words, it is the ability to capture and use knowledge as well as the better use and integration of new technology and manufacturing processes. Companies with lower absorptive capacity also have lower success in implementing new technologies because, without this capacity, businesses cannot expand their knowledge. The ability to collaborate and have communications infrastructure, which falls under the absorptive capacity, is very important for SMEs as they need assistance from external relationships due to the lack of internal resources. Absorptive capacity strengthens the relationship between the internal and external social capital and the process of Industry 4.0 implementation.

Agostini and Nosella (2019, 632) conducted research via an online survey in which researchers obtained 163 complete answers. Through research, it has been proven that it is more important to invest in social capital as it has a great impact on the probability of adoption of Industry 4.0; investments in advanced manufacturing technologies do not have a major impact on integration, even though investments in manufacturing are related to Industry 4.0 adoption. Levels of adoption and integration of Industry 4.0 are higher due to the internal social capital. However, in the case of external social capital, it is only together with the management support and absorptive capacity. In all cases, management support is significant in the integration of Industry 4.0 and influences the effectiveness of investments. (Agostini and Nosella 2019, 635) SMEs with strong internal and external social capital have a higher tendency to implement Industry 4.0, which is strengthened by absorptive capacity and management. Social capital and organisational context are more relevant than advanced manufacturing technologies. However, investing in advanced manufacturing technologies increases the intensity of adoption as well. This aspect is related to the financial resources whose lack could limit the success of the mentioned process. Hence, the right choice of financial investments and collaboration are crucial for SMEs. (Agostini and Nosella 2019, 636)

3.1.7 Progressive manufacturing technologies

As claimed by Mařík (2016, 52), it is difficult for companies of all sizes to estimate the return on investment before implementing Industry 4.0 technologies, and it is also challenging to estimate the price of the installation and maintenance of machines in comparison with the price of human labour.

The disadvantage is the high price of machines, which depends on the flexibility of production. If production is not flexible, machines often need to be changed or reprogrammed to adapt to market requirements. As already mentioned in relation to big data analysis, the problem in this area is also the insufficient education and expertise of people, for example, competence to perform additive manufacturing. (Mařík 2016, 56)

Since costs and expertise were mentioned, the barriers to using progressive manufacturing technologies are closely tied to the accessible financial resources and availability of the skilled and educated workforce.

3.1.8 Cybersecurity

Corallo et al. (2020, 13) claimed that cybersecurity could be considered one of the biggest challenges to implementing Industry 4.0 technologies. The estimated total annual cost of cyber-attacks is 6 trillion dollars in 2021 (Golden and Johnson 2018, 47). Moreover, the value of cybercrime is still growing. According to Corallo et al. (2020, 2), 48% of manufacturers claim in the undertaken study that they have been affected by cyber-attacks, and more than 20% suffered financial and other losses. For the economic growth of the company, it is important to fight proactively against breaches of cybersecurity as it is a crucial factor for the protection of the competitive advantage. 64% of leaders of companies claimed that cybersecurity is managed in an inadequate way which exposes businesses to the risk of a great financial loss. However, to avoid such a loss requires an input of financial resources to improve the technology-related aspects in small and mid-sized businesses. (Corallo et al. 2020, 12)

Corallo et al. (2020, 2) point out that economic damage can be caused by various reasons. Damage to the public image and reputation of the company can have a negative impact on revenue in general as the company might lose stakeholders and suffer sale losses. There is also the danger of penalties related to loss of confidential data of the manufacturing process resulting in violation of commercial agreements or penalties for the danger workers might be exposed. (Corallo et al. 2020, 7-8)

The size of loss can be assessed by quantitative and qualitative methods. Quantitative indicators consist of formulas that result in an estimation of the impact that a breach of cybersecurity had on the business. It incorporates costs related to machine repair, including removing broken parts, testing new parts, and their installation while taking into consideration time spent on these tasks. Other formulas add into the calculation also production waste and loss of profit, then financial penalties for reasons already mentioned. Qualitative indicators measure impact on business based on certain criteria on three levels – low, medium, and high. (Corallo et al. 2020, 7-9, 11-12)

Due to the fact that a breach of cybersecurity might result in costly penalties and securing of its sufficiency requires considerable investments, it appears that cybersecurity is related to financial resources as well, and the lack of finances could have a negative influence on it.

3.1.9 Implementation process length and reliability

The process of implementing Industry 4.0 creates many uncertainties and risks within SMEs. The success of the mentioned process requires a flexible interface as different methods, technologies and languages are included in integrating various components and tools. Stability within the enterprise ensures that systems are reliable and in order to achieve that, coordination across all organisational units is essential while introducing new technologies. (Horváth and Szabó 2019, 121-122)

As stated by Orzes et al. (2018, 1350), SMEs pointed out that a long process of implementation can result in interrupted production, high costs, and uncertain return on investment. Mentioned challenges are again in relation to financial resources whose lack could cause serious problems not only while implementing new technologies but also in the ordinary course of business.

3.2 Possible benefits of overcoming implementation barriers for SMEs

The benefits of using Industry 4.0 technologies are unclear for many SMEs. Some of the barriers that SMEs may encounter during the implementation of Industry 4.0 may seem negative at first sight, but in fact, by overcoming or adapting to them, they can gain many benefits and discover new solutions.

3.2.1 Cooperation with other businesses

As claimed by Schwab (2016, 63), an ability to adapt and constant innovation are the most important for Industry 4.0. SMEs that have speed and agility might have an advantage as

they are able to deal with disruption and offer innovation. For this reason, large organisations might invest in SMEs and create partnerships with smaller and innovative businesses.

Implementation of Industry 4.0 also brings new opportunities for cooperation with partnering institutions. (Müller, Buliga and Voigt, 2018, 8)

Companies can share resources that create a significant value for both businesses through collaborative innovation. Companies such as Siemens and Ayasdi are a great example of such a collaboration. Ayasdi helps to solve problems for Siemens by extracting insights from vast data. In exchange for this service, Ayasdi uses data analysis with real-world data for topological validation in order to expand the market. It is beneficial cooperation for both large businesses as well as for economies where this collaboration occurs. Mentioned partnership requires a search for partners, financial investments, development of a firm strategy, management of communication channels, and much more. (Schwab 2016, 57)

Thus, it can be argued whether it is less likely to create such collaboration in the case of small and medium-sized businesses.

Although, cooperation of enterprises of various sizes can be beneficial for large businesses, so for SMEs. Industry 4.0 research is mainly focused on large enterprises and at least on SMEs. However, large companies and SMEs are interconnected and can influence each other's activities. Large enterprises might be suppliers of SMEs and vice versa. In this aspect, the inability of SMEs to implement Cyber-physical systems because of the low level of digitisation became their advantage. Instead, they use Enterprise Resource Planning systems that enable SMEs to have a niche advantage – they offer products on an individual basis and are manufactured in small series. Implementation of Industry 4.0 brings various advantages to SMEs such as speed of production, reaction capacity, flexibility, fast reaction to malfunctions, and development of new products. Product spectrum might become broader and quality higher. The number of customers might increase due to the better interaction via automated online platforms. (Müller, Buliga and Voigt 2018, 2,7)

3.2.2 Business model

According to Müller, Buliga, and Voigt (2018, 3), a business model designs and conducts activities of the enterprise, interacts with stakeholders and deals with the research and implementation of new technologies as well. SMEs take into consideration all challenges

that the implementation of Industry 4.0 brings, but they try to understand the way to gain advantages from this change at the same time. The innovation of the business model is one of the mentioned changes. The goal of innovating a business plan is to increase the value of products as well as the loyalty of customers and to decrease costs faced by customers.

Such innovation can be achieved by implementing new technologies. On the one hand, SMEs claim it is an expensive process. On the other hand, it might have long-term benefits. A business model becomes demand-oriented, and the willingness of customers to pay might increase. (Müller, Buliga and Voigt, 2018, 8-9)

Thus, something that might appear as a hindrance, at first sight, might become a long-term benefit.

3.3 Comparison of SMEs with large businesses in the context of Industry 4.0 implementation

Considering the implementation of Industry 4.0, Horváth and Szabó (2019, 129) concluded that SMEs and large enterprises do not have equal opportunities. Given human resources, large businesses have more extensive opportunities for recruitment than SMEs, which are mainly focused on the availability of local workforce and use new technologies as a solution for the lack of skilled employees. Even though a global scarcity of experts with appropriate technological skills exists and affects enterprises of all sizes.

Expectations of high profitability and cost reduction are crucial for large enterprises. However, large profit is not crucial for SMEs as they do not use new technologies primarily to be profitable but to improve other aspects such as the already mentioned workforce. They also accomplish projects with lower returns while meeting their personal goals. Nevertheless, financial resources create the most significant barrier to implementing Industry 4.0 technologies for SMEs, which is not the case for large enterprises. (Horváth and Szabó 2019, 128-129)

Regarding market conditions, large enterprises depend on them. In contrast, SMEs are more focused on their niche advantage. Large businesses are also strongly focused on business model innovation as they face a big pressure from competitors. They need to adjust to new trends and follow developments which are accomplished by constant monitoring of all processes and opportunities. This scenario is different for SMEs since they are not primarily focused on the business model innovation, even though it could be beneficial for them. (Horváth and Szabó 2019, 128-129)

Considering efficiency and productivity, both are important for SMEs as well as large businesses. Furthermore, customer satisfaction is a crucial factor for SMEs. They try to perform the best services and offer high-quality products, so it is more likely that clients will return. Large businesses are similarly focused on large customers. However, smaller clients are not important to them. On the one hand, SMEs might face management issues that result in an inability to identify new opportunities for new technologies. On the other hand, organisational factors are not problematic as one strong CEO can lead a firm towards Industry 4.0 innovations; nevertheless, this might be an issue for large firms where the hierarchy is complex, and it might make the process of implementation more challenging. (Horváth and Szabó 2019, 128-129)

Giving consideration to integration and cooperation, they do not create a barrier for SMEs because, by implementation, they want to resolve emerging issues only. Though, it represents a problem for large businesses as they want to integrate new technologies within the entire network. (Horváth and Szabó 2019, 128-129)

4 FINANCIAL SUPPORT OF SMEs

As stated by Bondarevaa and Zatrochová (2014, 541), SMEs are vital for social development and a healthy economy, which is the reason for the support of their development by various institutions. The following subchapters deal with the financial support of SMEs, mostly provided by the European Union. Next, barriers to acquiring financial resources are pointed out, and as the last point, the government's involvement is mentioned.

4.1 Support by European Union

The numerous financial support possibilities are provided by the European Union (EU) to small and medium-sized businesses. Mentioned support includes grants and credits, guarantees, assistance, and financing of particular projects or new businesses. EU funds are financial instruments whose purpose is to increase the performance of countries, support various fields and economic growth. (Bondarevaa and Zatrochová 2014, 545)

According to Karafolas and Woźniak (2014, 2590), the European Union finances various projects within Europe directly or indirectly by supporting national funds. SMEs benefit from grants whose part is also managed by the European Investment Fund. SMEs are considered to be one of the main targets of financial support, which can be proven by the amount of investment of the European Union. Over the period of years 2014-2020, the EU contributed 1 trillion euros into various programs within the EU.

As stated by Agostini and Nosella (2019, 627), the Federal Ministry of Education and Research claimed that Industry 4.0 implementation could be significantly beneficial for SMEs; however, significant investments are required.

4.1.1 European Institutions

The EIB Group, which consists of the European Investment Bank (EIB) and the European Investment Fund (EIF), is mainly responsible for financing related to SMEs and digitisation. As it is explained in Figure 2, the European Commission decides on how the financial resources are allocated and also cooperates with the EIB Group or managing authorities of member states. (Europa.Eu 2016a)

The EIB provides loans through intermediaries, for example, commercial banks. The target of these loans is tangible and intangible investments by SMEs. The stable working capital provision and long-term funding needs of SMEs are based on these loans as well. (Karafolas and Woźniak 2014, 2592)

The main focus of financial support programs is on SMEs, as they are vital for the European economy. Funding is provided through financial institutions in European member states. Different types of financial assistance include equity funding, microfinance, guarantee, and loans. Institutions such as social investors, venture capital funds, or business angels, which decide on the conditions and parameters of financing, are part of the ways of distributing funds. (Europa.Eu 2016a) The central mission of the EIF is the support of SMEs by facilitating their access to finance. (Eif.Org 2019)

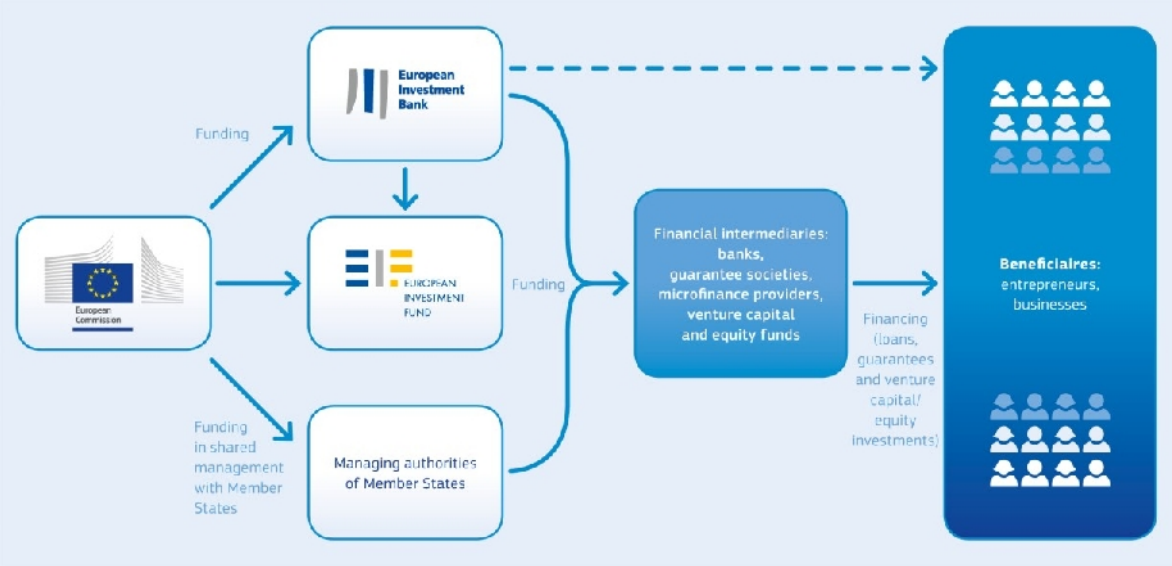

Figure 2 How it works (Europa.Eu 2021a)

4.2 EU support in the context of digitisation

The following subchapters briefly describe the means of support by the European Union with the purpose of digitisation, innovation, or help to SMEs in Europe. Assuming that SMEs have difficulty implementing Industry 4.0 due to insufficient funding, it is necessary to examine the availability of external financing for these enterprises in order to determine whether this barrier is removable.

4.2.1 COSME

The digital transformation of SMEs is supported mainly by the Programme for the Competitiveness of Enterprises and Small and Medium-sized Enterprises (COSME), which budget is over 2.3 billion euros that are also complemented by the European Fund for Strategic Investment. (Eif.Org 2019) Money from the budget is used to facilitate access to loans and financing through funding financial instruments. Budget is also used for the leverage effect. Through financial intermediaries, it is possible to mobilise about 35 billion euros. (Europa.Eu 2016c)

An essential part of COSME, primarily focused on digitisation, is the Loan Guarantee Facility (LGF). (Europa.Eu 2021a) In 2019 the COSME LGF was launched by the European Commission and EIF. The main focus of this digitisation pilot under COSME is the digital transformation of SMEs since the European Union is aware of the fact that lack of financial resources can be a major issue towards digitisation. (Eif.Org. 2019) Approximately 500,000 SMEs will benefit from loans with COSME guarantees. The amount of money that has been lent is more than 30 billion euros. (Europa.Eu 2016c)

Another part of COSME is the Equity Facility for Growth (EFG), managed by the EIF, which supports the growth and expansion of SMEs. (Eif.Org 2021) According to (Europa.Eu 2016c), 300 companies will benefit from the 2.54 billion euros investment of the EFG.

4.2.2 Horizon Europe

The predecessor of Horizon Europe was Horizon 2020, which was a program for research and innovation during the period 2014-2020 with a total budget of 77 billion euros. The focus of the mentioned program was to remove barriers to innovation as well as the support of SMEs. (EU Neighbours 2021)

At present, Horizon Europe is a research and innovation program with a total budget of 95.5 billion euros for the period 2021-2027. The main focus of investments is planned to be digital transitions, strengthening of science and technology, industrial competitiveness, innovation, collaboration, etc. The purpose of this program will be to reduce an administrative burden for applicants. (Directorate-General for Research and Innovation 2021)

The European Innovation Council (EIC) is part of Horizon Europe with a budget of €10 billion for the period 2021-2027. Its grants and investments are focused primarily on SMEs. During the EIC pilot phase in 2018-2020, around 5700 start-ups and SMEs benefited more than 5 billion euros and doubled their workforce. (Europa.Eu n.d.)

4.2.3 InvestEU

The investment plan for Europe, which time period is 2021-2027, is expected to mobilise 372 billion euros. Besides others, the focuses of the plan are research, innovation, and digitisation of the EU industry. The main focus of the financial support is SMEs and making the funding simpler and effective. (Europa.EU n.d.a)

4.2.4 DIGITALEUROPE

DIGITALEUROPE is an association whose main interest is the digitisation of all industries across Europe and the creation of an environment where people can benefit from digital technologies. Among the activities of DIGITALEUROPE belong legislation and establishment of industry policy positions as well as the implementation of policies related to digitisation within Europe. (Digitaleurope.Org 2018)

4.2.5 Factories of the Future

The EU initiated the title *Factories of the Future,* which enables enterprises to have a public-private partnership in order to ensure sustainable and competitive production. Moreover, enterprises with complementary capabilities can be brought together as one of government and industrial initiatives. (Müller, Buliga and Voigt, 2018, 4, 8)

The European Union's public-private partnership for innovation and advanced manufacturing research focuses on the fourth industrial revolution and the establishment of Factories 4.0 in participation with SMEs and other institutions. (Effra.Eu 2019)

European Union has visions towards digital transformation by 2030. Regarding goals of this vision, they include the digital transformation of business, thanks to which more than 90% of SMEs should reach at least a basic level of digitisation. The focus will also be paid to the education of the workforce and the establishment of policies concerning Industry 4.0. Based on this initiative, it is possible to deduce that European Union is dedicated to supporting digitisation and SMEs. (Europa.Eu 2021b)

4.3 Barriers to acquiring financial support

SMEs have difficulties accessing finance, and it is a problem that has an impact on their activity. However, the access to finance in the euro area is improving. Only 8% of SMEs have defined access to external resources as a major issue. Still, as shown in Figure 3, external financing for large enterprises is more accessible than for SMEs. (Bańkowska, Ferrando and Garcia 2020)

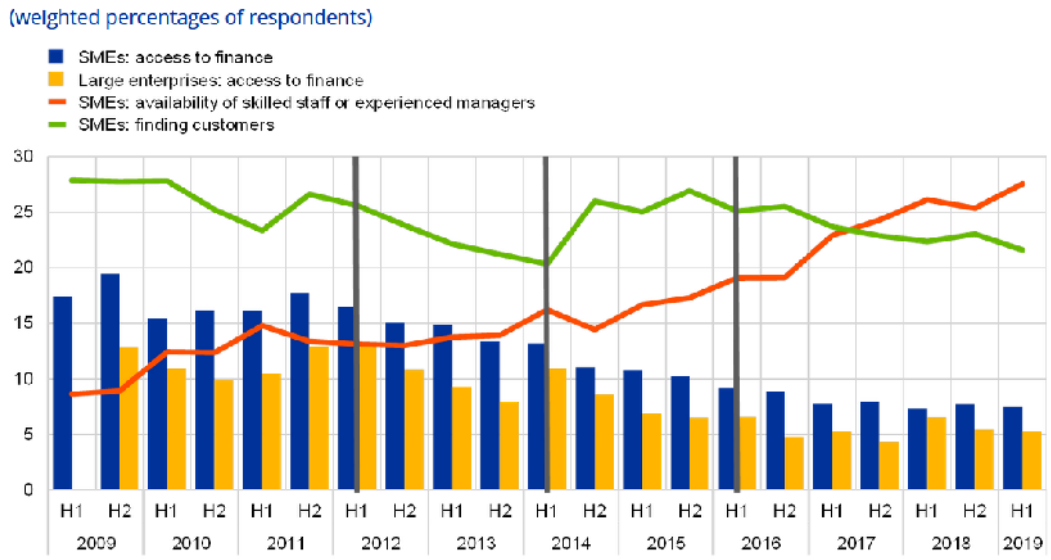

Figure 3 Most significant problems faced by euro area firms (Bańkowska, Ferrando and Garcia 2020)

(Bańkowska, Ferrando and Garcia 2020) claim that companies might struggle with external financing as they might be hesitant to apply for it because of the fear of rejection, their application was rejected, or they received a loan whose amount was not satisfactory, or its cost was too high.

Another barrier could be the bureaucracy related to applying for financial support, as it might be time-consuming and confusing.

Certain characteristics exist that might determine SMEs' access to external financings, such as the degree of innovation and age of the enterprise. As it is possible to observe in Figure 4, small and young enterprises belong in the group which has particular problems accessing external finance. On the one hand, mature SMEs have more opportunities. On the other hand, if the main focus of the enterprises is innovative activities, chances to obtain financing are lower as uncertainty is involved. SMEs need to focus on other diversified sources of finance as many SMEs use only one type of financing. (Bańkowska, Ferrando and Garcia 2020)

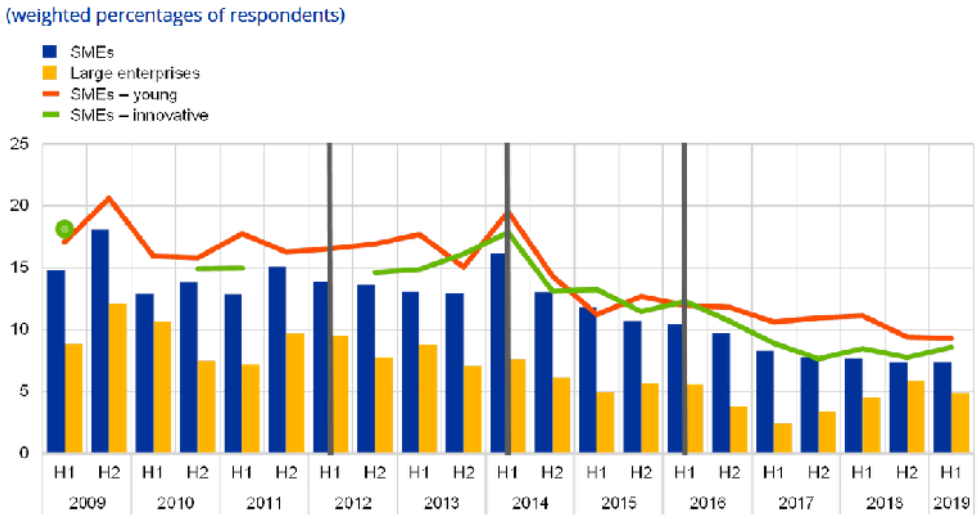

Figure 4 Financially constrained firms by age and size (Bańkowska, Ferrando and Garcia, 2020)

Bondarevaa and Zatrochová (2014, 543) claim that access to financial resources is insufficient for SMEs, and the acquisition of finances is costly.

Investors are willing to invest in SMEs only if they become owners of the share of the property. Investors usually have a desire to become managers. However, after selling their share to the further investor or initial owner, they leave. SMEs might have a negative attitude towards new shareholders because they are against the sale of shares in the future. Another issue is that SMEs might have problems employing instruments of risky investments. (Bondarevaa and Zatrochová 2014, 545)

4.4 Government support

Nowadays, governments are developing policies and measures to support the digitisation of companies financially. This assistance is provided through funds and institutional actions to support external relations of companies with universities, intermediaries, other companies, technology providers, etc. The aim is also to support education and training programs. These measures are targeted at SMEs because it is these companies that are experiencing difficulties with Industry 4.0. Today, thanks to government measures, many SMEs have been able to invest in advanced manufacturing technologies and strengthen relations with external partners. (Agostini and Nosella 2019, 626)

Forms of financial support can be divided into two groups – direct and indirect forms. Into direct forms belong grants from the European funds, export premium, additional charges, etc. Indirect financial support consists of tax allowances, reduction of interest,

financial guarantees, etc. A wide network of organisations exists within countries on the level of state, regions, and individual towns with the goal to provide SMEs with support. (Bondarevaa and Zatrochová 2014, 547)

It is essential to find ways of cooperation between government and business, as this affects relations not only within the state but also between countries. (Schwab 2016, 77)
It should be in the interest of the government to support businesses in their transition to Industry 4.0 as the insufficient financial resources and efforts to save costs can have an influence over state affairs. For example, cybersecurity does not have an influence only on international security but also on state relationships; unemployment causes social instability and many other uncertainties that might evolve together with the new emerging trend. (Schwab 2016, 80)

5 SUMMARY AND LIMITATIONS

The intention of summarising the work is important as the topic of Industry 4.0 is quite complex, and various aspects of this emerging trend were mentioned throughout the work. It is also necessary to summarise the limitations that may lead to insufficient work accuracy but which could not have been removed or avoided.

The beginning of the work focused on the clarification of the terms related to Industry 4.0 and its underlying technologies. These new concepts were briefly explained in order to clarify the meaning of Industry 4.0 as the understanding of it seems to be very important for the process of implementation. This part was followed by the evaluation of advantages and disadvantages resulting from Industry 4.0 implementation. Positive impact on the environment, effectiveness, quality, costs, and economic growth belong among the advantages, to name a few. Disadvantages involve the need to overcome certain barriers such as storage of big data, training of employees, lack of financial resources, etc.

The readiness of enterprises was assessed as well, according to which it can be concluded that the majority of enterprises of various sizes are still not ready for Industry 4.0 implementation.

The main part of the work consisted of barriers related to the implementation of Industry 4.0. Various barriers were mentioned, such as competition or lack of willingness to implementing new technologies, but the most resonant barriers were lack of financial resources as well as lack of skilled and educated workforce. These two main barriers – social context and financial resources are interconnected. Interconnection can be explained by the example of the cooperation of enterprises that were recommended to businesses to balance possible deficiencies such as lack of a skilled workforce. However, successful cooperation requires digitisation, and digitisation requires financial resources.

Next, benefits resulting from cooperation with other businesses and innovation of business model were stated as well.

Afterwards, a comparison of SMEs with large enterprises in the context of Industry 4.0 was briefed, according to which it was concluded that SMEs and large enterprises do not have equal opportunities to implement new technologies. They also have different goals and focuses, a combination of which could possibly be beneficial. Large businesses can benefit from the agile production and niche advantage of SMEs. However, some obstacles and goals are similar for enterprises of all sizes, such as lack of skilled workforce or effort to achieve high productivity.

Due to the fact that many SMEs indicated a lack of financial resources as the main problem, exploration of the validity of the statement was necessary, as well as to find out the possibilities to overcome the stated problem. It was found that the European Union supports SMEs because their prosperity is in the EU's interest. Various programs of the EU dedicated to supporting SMEs were mentioned in order to verify this claim. Different types of financial support are available, but there are some obstacles in their acquisition depending on various factors such as age, size, or field of focus which have also been summarised.

The last part of the work is dedicated to the research limitations because its accuracy needed to be assessed.

First of all, an insufficient amount of academic sources related to the specific points on which the work is focused is available. Despite the fact that a seemingly sufficient number of sources was used in order to develop this paper, it is not possible to draw conclusions with absolute certainty. As was already mentioned, researchers are more likely to be focused on large enterprises in the context of Industry 4.0. In relation to the mentioned problem, the number of respondents of surveys or interviews conducted with the aim to gain information from representatives of SMEs is not sufficient to draw clear conclusions about the position of SMEs in the Industry 4.0 context. Moreover, not every country in Europe has been mentioned or examined. Thus, the work cannot be used to define the situation of SMEs across entire Europe. As researches often focus on large economies, such as China, United States, or India, certain information about the advantages and disadvantages resulting from the Industry 4.0 implementation was used from the research conducted in the United States.

Another problem related to the source arises as technologies are changing at an unprecedented rate. Academic sources published only a few years ago might be outdated because technologies and Industry 4.0 are developing at a tremendous pace.

It is difficult to make predictions for the future of Industry 4.0 because the situation of the global pandemic of Covid-19 has not been taken into consideration while accomplishing this work. It could be a driving force for companies to implement Industry 4.0 as quickly as possible in order to minimise the amount of workforce present at work, or it could also become a great barrier for businesses due to the unfavourable economic situation.

The recommendation that small/medium-sized businesses should cooperate with large companies is based on observing successful cooperation between large companies. Evi-

dence of the successful cooperation of SMEs with large enterprises was not found, so it is a rather logical justification for possible scenarios based on the available facts.

It was concluded that the lack of financial resources could be overcome by support from the European Union. However, there are no confirmatory statements from SMEs, whether the financial support is sufficient. Again, it is possible only to assume this from the available facts – the amount of the financial resources dedicated to helping and a strong desire of the European Union to support SMEs.

Due to the unavailability of considerable amounts of data, further research needs to be conducted to examine the cooperation of SMEs and large businesses, allocation of financial resources obtained from grants, and costs resulting from the recruitment of a qualified workforce.

CONCLUSION

Based on the statements of numerous SME representatives within Europe, it is possible to conclude that there are two biggest barriers to Industry 4.0 implementation - lack of financial resources and lack of educated and skilled workforce.

It appears not possible to identify only one barrier as the most significant because all the barriers mentioned in this work are interconnected, and some other barriers SMEs might face are in close relation to these. A good example of an area that faces such barriers is cybersecurity, which can be improved exactly by combining a skilled workforce and sufficient financial resources.

First, companies need dedicated owners and flexible management support who are willing to implement Industry 4.0 and desire to apply for external financing in case of lack of financial resources. SMEs are one of the major concerns of the European Union, and various ways of financial support are accessible. After receiving this support, the management is able to create a precise strategy, decide about the next approaches towards digitisation and further investments. The management, formed of educated and skilled people, can also secure the guidance for the company's employees, which includes overseeing the advancement of their education and skills, and support internal as well as external collaboration within enterprises, which could be a possible solution for various problems of SMEs in the context of Industry 4.0 implementation. Even if SMEs have sufficient financial resources, Industry 4.0 implementation would not be successful without proper strategy and knowledge. Thus, social context is crucial in this matter.

However, even the social context requires financial resources as the demand for the skilled and highly educated workforce or their training could cause an increase in labour cost. The most important feature of companies for Industry 4.0 implementation is the accurate interpretation of the concept and its further integration within the company through proper management structure and sufficient support from competent leaders.

The initial statement, which claims that only large enterprises have possibilities to implement Industry 4.0, as it requires a lot of financial resources, is correct only partially because SMEs have possibilities to access additional financial resources. Furthermore, the implementation of Industry 4.0 requires more than that. In order to assess the validity of the prediction that inequality between large enterprises and SMEs in the context of Industry 4.0 will cause serious disadvantages of SMEs, it is possible to conclude that certain inequality does exist. Thus, SMEs need to exert extra effort to compensate for that.

Implementation of Industry 4.0 seems important if a company wants to gain an edge over its market competitors. Nevertheless, SMEs might not necessarily be driven out of the market by large businesses, even though SMEs and large enterprises do not have equal opportunities. Collaboration between businesses is vital, and SMEs can use their agility and niche advantage to build relationships with large enterprises. While the research has shown that there certainly are barriers to implementing Industry 4.0 for SMEs, the companies should be sufficiently motivated by the possible benefits. Enterprises ahead of the curve that have already managed to implement core Industry 4.0 concepts and technologies might serve as an example for the rest of the sector, showing that there are tangible benefits and improvements to be achieved by embracing the fourth industrial revolution.

The issues accompanying adaptation to Industry 4.0 are often too complex to understand in-depth to an uninvolved observer; therefore, further research in numerous fields needs to be conducted as companies are uncertain about the outcomes of this undertaking.

What can initially be considered as an advantage may later turn out to be a hindrance, as it is, for example, with the use of big data. It brings a considerable benefit of the availability of real-time information. However, it is also a burden for employees as they need to work with a large amount of data that requires storage, cybersecurity, etc. Another example could be automation which should be understood positively. Although, automation bias or paradox of automation might accompany the implementation of this trend. Based on a couple of examples, there is a certain degree of caution to be had by every company striving to adopt all the technologies still in development. Only time will tell the real impact, and possible future challenges as Industry 4.0 is still in its infancy on a global scale, and the desires of enterprises to implement new technologies could be strongly affected by the global pandemic, making them shift their attention to more pressing issues.

Economic, social, and political systems have to adjust to an array of emerging trends in relation to technological advancements not only in manufacturing but all other industrial fields as well. Stakeholders and leaders of the global industrial societies have the responsibility to collaborate and cooperate in order to better understand the opportunities and challenges of Industry 4.0 if they have sustainable economic development in mind for the future of mankind.

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LIST OF ABBREVIATIONS

CEO	Chief Executive Officer
CNC	Computer Numerical Control
CXOs	C-level executives
COSME	Competitiveness of Enterprises and Small and Medium-sized Enterprises
EFG	Equity Facility for Growth
EIB	European Investment Bank
EIC	European Innovation Council
EIF	European Investment Fund
EU	European Union
H2M	Human-to-Machine
IT	Information Technology
LGF	Loan Guarantee Facility
M2M	Machine-to-Machine
NC	Numerical Control
SMEs	Small and Medium-sized Enterprises
Wi-Fi	Wireless Fidelity
3D	Three Dimensional

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