

THE IMPACT OF INDUSTRY 4.0 IMPLEMENTATION ON ENTERPRISE DEVELOPMENT IN SELECTED EU COUNTRIES: A COMPARATIVE ANALYSIS

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Purpose: This paper aims to assess the impact of Industry 4.0 implementation on enterprise development within the digital economy, with particular emphasis on small and medium-sized enterprises (SMEs). The study also compares the level of digitalization and Industry 4.0 adoption in selected European Union countries: Denmark, Germany, Hungary, and

Design/methodology/approach: The research is based on a survey conducted among 60 Polish enterprises of different sizes and a comparative analysis using secondary data from the Digital Economy and Society Index (DESI) and existing literature. The study examines the level of Industry 4.0 awareness, key technologies, investment readiness, and digital competencies.

Findings: The results indicate that medium and large enterprises demonstrate a higher level of Industry 4.0 adoption and investment capacity than small enterprises, which face financial and knowledge-related barriers. Cybersecurity, cloud computing, simulations, and system integration are identified as the most relevant technologies. The comparative analysis shows that Poland remains behind Denmark and Germany in terms of digital maturity and advanced digital skills, while its position is comparable to Hungary.

Practical implications: The findings highlight the importance of strategic planning, gradual implementation of Industry 4.0 solutions, and continuous employee training to enhance enterprise competitiveness, particularly in SMEs.

Originality/value: The paper provides a concise empirical and comparative perspective on Industry 4.0 implementation across enterprises of different sizes in selected EU countries, offering practical insights for managers and policymakers supporting digital transformation.

Keywords: Industry 4.0, Digital Economy, Strategic Management, SMEs; Digitalization; Enterprise development.

Category of the paper: Research paper.

1. Introduction

The strategic focus of the contemporary manufacturing industry integrates advanced digital information technology into various application fields of the manufacturing industry. With the advent of Industry 4.0, multiple aspects of manufacturing production, value creation processes, and business models have undergone tremendous changes. Manufacturing companies of all sizes worldwide continue to develop in the direction of intelligence, and formulating a reasonable and efficient digital strategy will steadily boost their competitive advantages (Li et al., 2022; Lasi et al., 2014; Olsen, Tomlin, 2020; Sharma et al., 2021). One of the key challenges of Industry 4.0 is to make the production systems more flexible and collaborative. To achieve this, the Industry 4.0 paradigm relies on the strategic use of enabling technologies. It offers a quick response to customer demand, improves productivity, and allows stakeholders to make quicker decisions in real-time (Alcácer, Cruz-Machado, 2019; Manavalan, Jayakrishna, 2019; Tortora et al., 2021). By merging the concepts of Industry 4.0 and the digital economy, it is possible to improve and automate processes at various levels of the economy as well as the processes within the enterprises.

Each of the four industrial revolutions was marked by the introduction and spread of inventions that caused significant and deep changes in every area of economic and social life. These revolutions enabled the transformations in production processes and work organization thereby improving efficiency (Grześ, 2020). Currently, the economy is developing and changing at a very fast pace, with an increasing emphasis on digital technologies and their implementation in enterprises across various industries. Digitalization is one of the numerous challenges facing industrial companies (Łobejko, 2018; Kuzmin, 2022; Pech, Vrchota, 2020; Castelo-Branco et al., 2023), and it is Industry 4.0 that offers a great opportunity to enhance the competitiveness of small- and medium-sized enterprises (Schumacher et al., 2019; Huang et al., 2019).

1.1. Digitization of processes in enterprises

Digitization, in its original meaning, referred to the conversion of analog information into digital formats Federal Ministry of Food and Agriculture of Germany (2022), distinct from digitalization, which considers a broader adoption of digital technologies (Vrana, Singh, 2021; Barmuta et al., 2023). Over time, this term expanded its meaning by including the use of data processed into digital form by computer applications (Rogalewski, 2020; Adamczak et al., 2023; Schniederjans et al., 2020; Egorov et al., 2020). Nowadays, digitization is seen as a process and involves the use of information or digital technologies to optimize an existing business for cost savings or improve customer service (Verhoef et al., 2021). Today, digitization and digitalization have blended their meanings, as the conversion of information form into a digital one seems obvious. Therefore, it now has a much more horizontal concept, including

the digital revolution (also referred to as the digital transformation) Federal Ministry of Food and Agriculture of Germany (2022). Digital transformation involves inevitable changes in the operation of enterprises, at all levels of enterprise structures, processes, models, strategic action systems, goals, and values, and it constitutes a key element of competitiveness. Inseparable elements of digital transformation are new digital technologies that influence the growth of enterprises, bring new values and quality, and define business future based upon digital technologies, products, services, and solutions (DeStefano et al., 2017; Yang et al., 2021; de Lucas Ancillo, Gavrilă, 2023). New digital technologies such as Artificial Intelligence, AI-based services, Big Data, Cloud Computing, Internet of Things, or on-demand 3D print/prototyping, accelerate the digital transformation of enterprises, providing new opportunities for economic development (Baines, Lightfoot, 2013; Ricci et al., 2021; Rojek et al., 2022; Wang et al., 2023).

1.2. Digitalization in strategic management

The incorporation of digital technologies into strategic management increases productivity by automating numerous tasks, enabling companies to achieve more in less time, and by offering personalized products and services with a better quality and customer experience (Hahn, 2020; Wei et al., 2024). Enterprises are expected to continuously improve in the area of strategic management as it involves defining organizational goals, creating policies and strategies, and directing activities to achieve these goals (Wang et al., 2023; David, 2011; Radicic, Petković, 2023). The main goal of strategic management is to make decisions that will provide a long-term competitive advantage for the organization. It consists of several stages: setting business goals, developing policies and action plans, and creating strategies to achieve these goals (Troise et al., 2022; Kraus et al., 2023; May, Hui, 2023). As Ayitey has put it in the (Ayitey 2010), “Strategic management is the art and science of formulating, implementing, and evaluating cross-functional decisions that will enable an organization to achieve its goals. It is the process of determining the organization’s goals, developing policies and plans to achieve those goals, and allocating resources to implement the policies and plans to achieve the organization’s goals. Strategic management therefore integrates the activities of various functional areas of a company to achieve organizational goals. It is the highest level of managerial activity” (Ayitey. 2010).

In the era of digital transformation, new technologies significantly affect business processes and strategic management. The introduction of new digital technologies to all areas of a company’s activity radically changes its functioning and the way it delivers value to customers. Digitalization is changing the traditional competitive landscape of companies. The right combination of digital technology, information, and physical assets can provide a digital advantage that can be a competitive advantage (Bozintan et al., 2023; Rêgo et al., 2021; Li et al., 2018). Digitalization triggers the use of specific new digital technologies (e.g. with AI – the analysis and decisions can be based on artificial intelligence methods, self-learning, self-

optimizing approaches and algorithms, etc.). Digitalization has a huge impact on business management strategy, providing opportunities for improving quality, efficiency, and innovation at the operational level, and opportunities for growth and gaining market advantage at the strategic level. This means integrating technology with every aspect of the organization from customer contacts to internal operations, completely changing the way a company creates and delivers value, streamlining business processes, reducing costs and increasing efficiency, while generating revenues (Schwertner, 2017; Bughin et al., 2021; Sestino et al., 2020).

Digitalization of companies is inevitable these days. Investing in increasingly modern IT systems is very expensive, but necessary. Companies investing in IT development develop their products and become more competitive in the market (Olbrys, Smoliński, 2020; Galanti et al., 2023; Varoglu et al., 2021). Digital transformation for business models requires the use of new methods that will be managed digitally. Digital transformation allows observing all business operations performed and remote monitoring with control and optimization in real-time.

The objective of this paper is to examine and summarize the impact of Industry 4.0 implementation on the development of small- and medium-sized enterprises (SMEs). This research includes a comparative analysis across selected European Union countries, specifically Denmark, Germany, Hungary, and Poland, to explore cross-country differences and similarities in how SMEs are leveraging Industry 4.0 for their growth and competitiveness.

2. Materials and Methods

The study aims to present the impact of Industry 4.0 implementation on enterprise development in selected EU countries through a comparative analysis. The implementation of this goal was focused on analyzing the impact of Industry 4.0 implementation on the development of small and medium-sized enterprises (SMEs). This study includes a comparative analysis of selected enterprises across selected European Union countries. As part of the conducted research, the results of the comparative analysis conducted in Poland were compared with selected EU countries, i.e. Germany, Denmark, and Hungary.

2.1. Analysis and evaluation of Industry 4.0 implementation in Polish SMEs

The research included a survey conducted among 60 companies from Poland. The companies were characterized by transport, production, and financial services. They provide their services in the country and abroad. In order to better present the impact of Industry 4.0 on Polish enterprises, they have been divided according to their size:

- small (employing less than 50 people),
- medium (employing from 50 to 250 people),
- large (employing more than 250 people).

The division by size of companies in the survey allows for a better illustration of the stage of implementation of Industry 4.0 that Polish companies are at. On this basis, it is also possible to compare which sizes of companies perform better in the survey.

2.2. Industry 4.0 in Small Enterprises

Small enterprises are those that employ fewer than 50 people and whose total annual balance sheet does not exceed EUR 10 million Agencja Rozwoju Pomorza (2022). The five-question survey was attended by 20 small businesses from across Poland, of which 60% were managed by men and the remaining 40% by women. Respondents had to answer five questions about Industry 4.0. The first question was related to the knowledge of the Fourth Industrial Revolution in enterprises. 65% of respondents are familiar with its concept, while 35% of respondents had no experience with the issue of Industry 4.0 (see Figure 1).

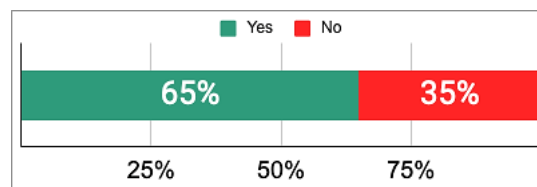


Figure 1. Small enterprises – Question 1 – Did you have anything to do with the term Industry 4.0?

Source: own research.

Next, respondents were asked about Industry 4.0 technology solutions that would be important or are important to the company. The participants said they have 9 Industry 4.0 technologies/contexts at their disposal and could select up to 3 answers about technologies they use in their companies or would be very useful in the functioning of the company. The most frequently chosen technology/context was Cybersecurity with a result of 27%. In the second place (*ex-aequo*), were two technologies: Augmented Reality (15%), which could be used in companies, e.g. for employee training purposes, and horizontal/vertical software integration. Not far behind AR and integration was Cloud Computing with a score of 13%, which would, for example, support mobile management and real-time performance. The rest of the technologies of the 4th revolution were chosen reluctantly, because only 8% of respondents chose Big Data, and with a score of 7%: Autonomous Robots and the Internet of Things. According to the respondents, in enterprises, additive manufacturing (3D printing) (5%) and simulations (3%) are less important (see Figure 2).

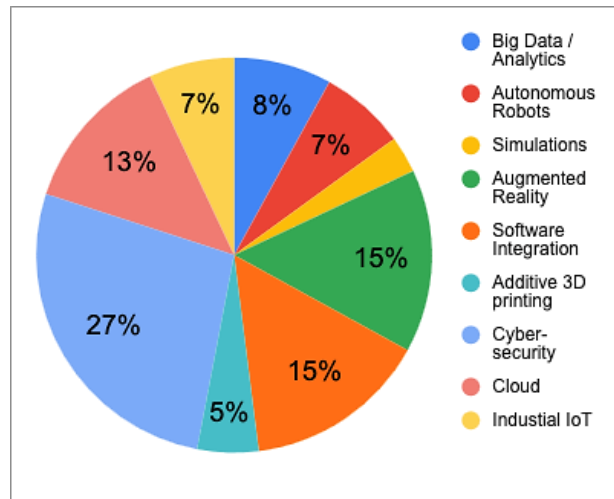


Figure 2. Small enterprises – Question 2 – Which digital technologies of Industry 4.0 do you consider important for your Enterprise? (choose max three most relevant).

Source: own research.

The research also examined the financial commitments small businesses were willing to make in Industry 4.0 to grow their operations. As for the small enterprises, the most frequently selected amount was between EUR 25,000 and EUR 75,000, accounting for 38% of the responses. The second most common choice was up to EUR 25,000, representing 24%. In third place, tied at 14%, were two ranges: EUR 75,000-125,000 and EUR 125,000-175,000. The least chosen option, at 10%, was an investment above EUR 175,000, as presented in Figure 3.

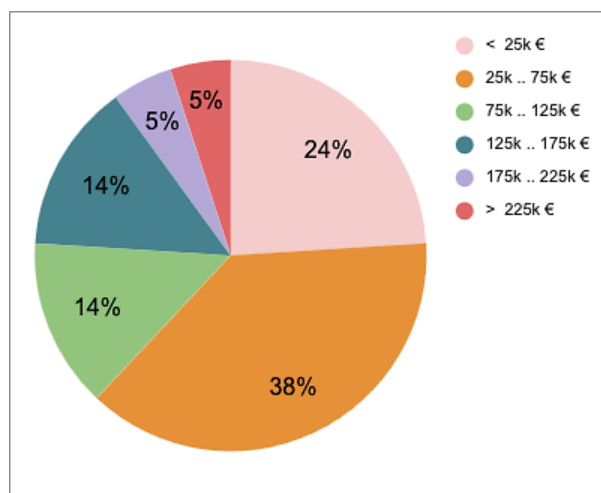


Figure 3. Small enterprises – Question 3 – How much are you willing to invest in the digital technologies of Industry 4.0 in order to advance your enterprise?

Source: own research.

The respondents were also asked to answer a question about the benefits resulting from the use of Industry 4.0 technologies (see Figure 4). The most popular answers were benefits such as increased productivity, competitiveness, and cost optimization (80%). For the remaining 20% of respondents, the benefits were not attractive, because at the very beginning, it involved

huge costs for the company, which, in their opinion, may not pay off in the future, and as a result, the company will go bankrupt.

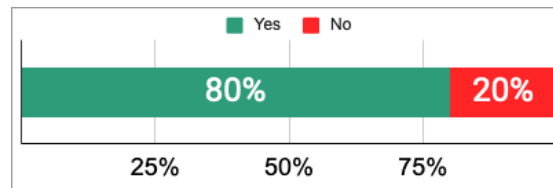


Figure 4. Small enterprises – Question 4 – Would the benefits of using Industry 4.0 technology (such as increasing productivity, competitiveness, cost optimization, etc.) be attractive to your enterprise?

Source: own research.

The last question, which was asked of respondents of smaller companies, aimed to check whether these companies will link their future with the development of Industry 4.0 technologies. As many as 75% of respondents declared that they will link their future with a given program due to the many benefits that they can achieve. On the other hand, 1/4 of respondents will not be associated with Industry 4.0 technologies. The most common reason they indicated was the lack of appropriate knowledge about Industry 4.0 and ambition to develop their company.

In summary, the survey shows that more than half of small businesses are familiar with the issue of Industry 4.0. For companies, technologies are very interesting and can have a positive impact on their overall functioning. A barrier that may be insurmountable for certain companies is the amount that must be invested at the very beginning to develop the technology. As much as 3/4 of companies declared that they would link their future with the Fourth Industrial Revolution to develop their company. The remaining companies that have not decided on Industry 4.0 will have a very hard time catching up with companies with technologies resulting from Industry 4.0.

2.3. Industry 4.0 in Medium Enterprises

Medium-sized enterprises are defined as those employing between 50 and 250 people and whose total annual balance sheet does not exceed EUR 50 million Biznes Rangers (2022). A five-question survey was conducted among 20 medium-sized enterprises across Poland, 75% of which were managed by men, and the remaining 25% by women. Respondents had to answer five questions about Industry 4.0. The first question (Figure 5) was related to the knowledge of the Fourth Industrial Revolution in enterprises. 80% of respondents are familiar with its concept, while 20% of respondents had no experience with the issue of Industry 4.0.

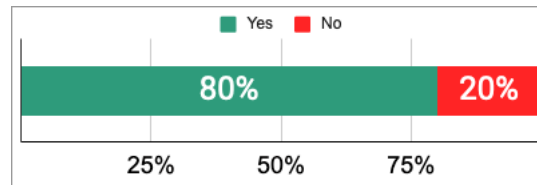


Figure 5. Medium enterprises – Question 1 – Did you have anything to do with the term Industry 4.0?
Source: own research.

Next, the respondents were asked about the Industry 4.0 technological solutions that would be important or are important to them in the company. The respondents who took part in the survey had 9 Industry 4.0 technologies at their disposal and could choose a maximum of 3 answers. According to the respondents, the most important technological solution in companies was Cybersecurity (28%), which would ensure data security. In second place, according to the respondents, with a result of 17% was Cloud Computing, thanks to which companies can manage performance, as well as simulations to, for example, supervise production. The third place was taken by horizontal/vertical software integration (15%), which can improve existing IT systems. The least frequently chosen Industry 4.0 technologies by respondents were Big Data (7%), while autonomous robots and AR were with a result of 5%. The respondents considered AR and additive manufacturing to be the least needed technological element in their companies (see Figure 6).

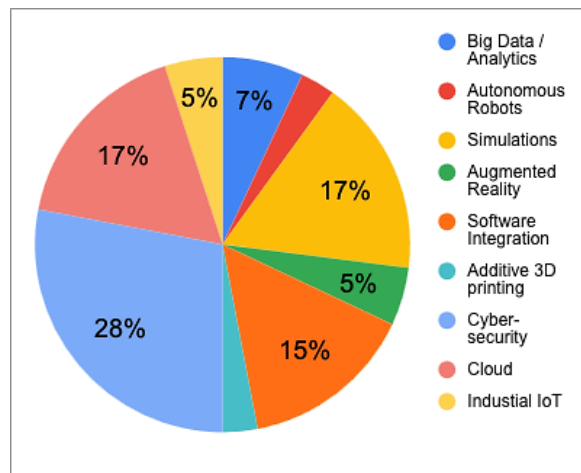


Figure 6. Medium enterprises – Question 2 – Which digital technologies of Industry 4.0 do you consider important for your Enterprise? (choose max three most relevant).

Source: own research.

The third question respondents were asked to answer concerned the amount of investment in Industry 4.0 technologies for their company's development, depicted in Figure 7. The most frequently chosen investment range was between EUR 25,000 and 75,000, representing 38% of all responses. In second place, with 24%, was the range of EUR 75,000 to 125,000, followed closely by EUR 125,000 to 175,000. The fewest respondents indicated they would invest not more than EUR 25,000 (9%) or above EUR 175,000 (10%).

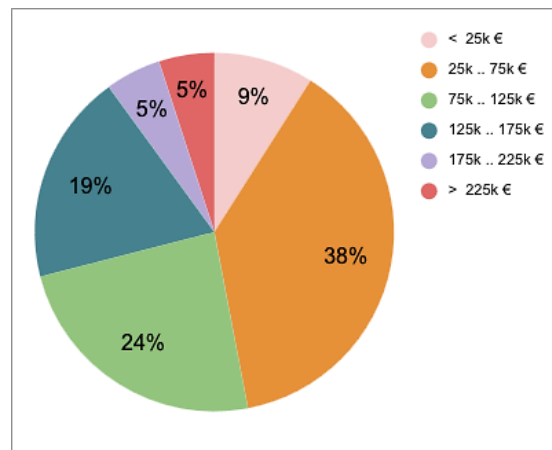


Figure 7. Medium enterprises – Question 3 – How much are you willing to invest in digital technologies of Industry 4.0 in order to advance your enterprise?

Source: own research.

Respondents were also asked whether benefits such as increased productivity, competitiveness, or cost optimization resulting from the use of Industry 4.0 technologies would be attractive to them (see Figure 8). As many as 90% of respondents answered YES to the benefits resulting from Industry 4.0, while 10% of respondents are still not convinced about the benefits resulting from the Industrial Revolution. The main fear that will once again appear is the possibility of bankruptcy of the company. Companies also have concerns about changes related to the industry, specifically the restructuring of the company. The fifth question, and the last one, that the respondents had to answer, concerned the future of connecting with Industry 4.0 in order to develop their company. As many as 85% of the respondents will connect their future with Industry 4.0 because the technologies are very attractive to them and future-proof for the further running of their company. Unfortunately, 15% of the respondents will not connect with Industry 4.0. The reason they indicated is the fact that the company operates on an internal application and there is no need to introduce Industry 4.0.

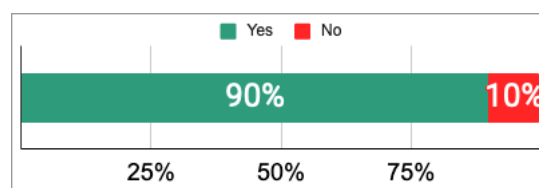


Figure 8. Medium enterprises – Question 4 – Would the benefits of using Industry 4.0 technology (such as increasing productivity, competitiveness, cost optimization, etc.) be attractive to your enterprise?

Source: own research.

In summary, the survey shows that more medium-sized enterprises are familiar with the issue of Industry 4.0 compared to small enterprises. The former would invest significantly more money to develop technology because their budgets are generally larger than those of small companies. Medium-sized enterprises, investing in Industry 4.0 technologies, see the possibility of developing themselves through technology and increasing their competitiveness on the market.

2.4. Industry 4.0 in Large Enterprises

Large enterprises are those that employ 250 or more employees and whose total annual balance sheet exceeds EUR 50 million Nawrocki (2022). The five-question survey was attended by 20 large enterprises from all over Poland, 90% of which were managed by men and the remaining 10% by women (see Figure 9).

The respondents answered five questions related to the Fourth Industrial Revolution. The first question concerned the respondents' familiarity with the issue of Industry 4.0. 95% of the respondents knew its concept, while the remaining 5% had no contact with this issue.

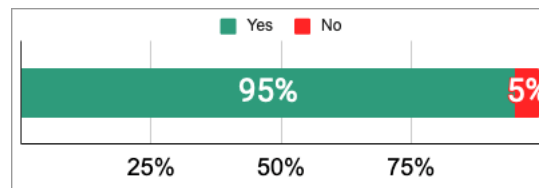


Figure 9. Large enterprises – Question 1 – Did you have anything to do with the term Industry 4.0?

Source: own research.

Then, respondents were asked to mark three technological solutions that are part of Industry 4.0 and would be or are useful in their companies. The respondents focused most on cybersecurity with a score of 25%, which will allow them to secure company data. In second place was simulation with a score of 18%, and in third, with a score of 15%, horizontal and vertical software integration, which will improve the functioning of the company. Respondents with the same score of 11% chose autonomous robots, which can support the system, and the cloud, thanks to which there is the possibility of mobile performance management in real-time. BD technology was in 6th place with a score of 10%. The respondents considered IoT, augmented reality, and additive manufacturing using 3D printers to be the least needed technological element in their companies (see Figure 10).

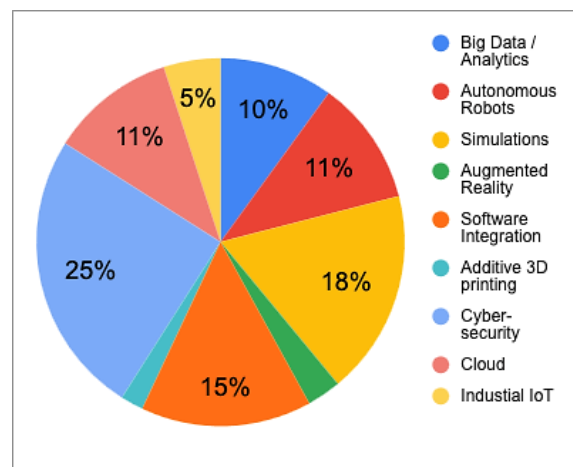


Figure 10. Large enterprises – Question 2 – Which digital technologies of Industry 4.0 do you consider important for your Enterprise? (choose max three most relevant).

Source: own research.

The next question the respondents faced was related to the previous one, as they were asked to determine how much they would invest in the selected Industry 4.0 technologies deemed useful for their company (see Figure 11). The most common investment range, chosen by 40% of respondents, was between EUR 125,000 and EUR 175,000. The second most selected range was EUR 75,000 to EUR 125,000, followed closely by the EUR 175,000 to EUR 225,000 range. Only 10% of respondents indicated they would invest between EUR 25,000 and EUR 75,000 or more than EUR 225,000. The least frequently selected option was an investment of up to EUR 25,000.

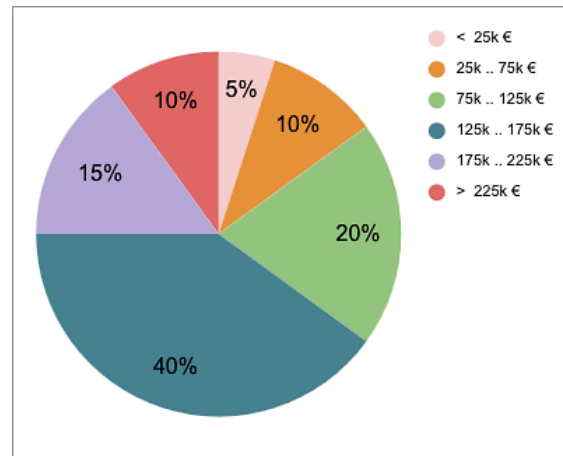


Figure 11. Large enterprises – Question 3 – How much are you willing to invest in digital technologies of Industry 4.0 in order to advance your enterprise?

Source: own research.

The next question concerned the benefits of Industry 4.0 technologies. The respondents had to answer the question of whether benefits such as cost optimization, increased productivity, better planning, and monitoring of manufacturing processes would be beneficial for their companies. As many as 95% of respondents answered that the above-mentioned benefits would be beneficial for their company. Only 5% of all answers were negative. The only company for which the benefits would not be attractive answered that the company does not need Industry 4.0 technologies because it functions perfectly without them (see Figure 12).

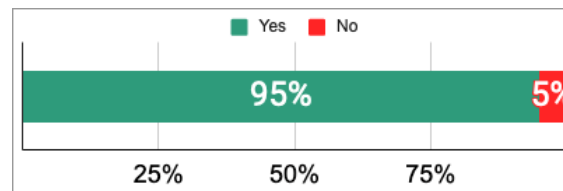


Figure 12. Large enterprises – Question 3 – How much are you willing to invest in digital technologies of Industry 4.0 in order to advance your enterprise?

Source: own research.

The last question that the respondents had to answer was aimed at obtaining a final answer regarding the future of Industry 4.0 in their companies. 90% of the respondents answered yes, and the benefits offered by the Fourth Revolution are very attractive and beneficial for them, which is why in the future they are associated with the development of Industry 4.0 technologies. Only 10% of companies will not be associated with Industry 4.0. Companies will not be associated with their future because it is associated with necessary procedures that need time, and for the company it is too long to wait for any effects. In addition, they are not convinced about Industry 4.0 technologies. In summary, the survey shows that the vast majority of large enterprises are familiar with the issue of Industry 4.0. Enterprises with a significantly large budget would be much more willing to invest money in Industry 4.0 technologies, because they are aware that the money invested will prove to be an ideal investment in the future, which will then be associated with financial benefits, as well as in building a strong enterprise on a very competitive market.

2.5. Comparison between Polish and selected EU countries' SMEs in terms of digital economies

This chapter contains the comparative research performed by confronting the literature-based data on selected EU countries' digital economies, with the survey-based information acquired from the decision-makers of 60 Polish enterprises.

2.5.1. Comparison of the Polish and Danish digital economies

The comparative analysis of the Polish and Danish digital economy aims to show the differences and the reasons that divide these two countries in the subject of the digital economy. In 2021, in the Digital Economy and Society Index (DESI) ranking, the Polish digital economy was ranked 24th, while Denmark was ranked 2nd among the 27 EU member states. 60 respondents took part in the analysis.

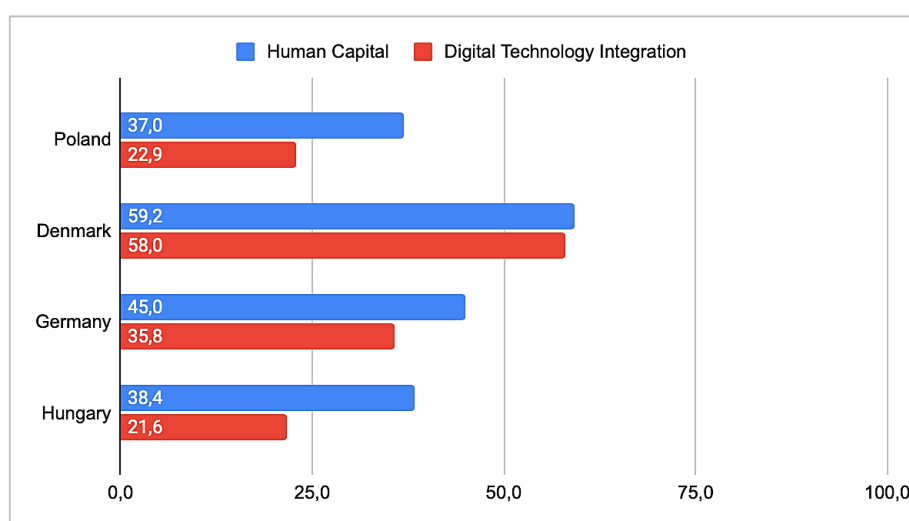


Figure 13. Comparison of the Polish and other selected European countries' digital economies in the use of digital technologies and the human capital regarding digital skills.

Source: own work, based on European Commission (2022b, e, a, d, c).

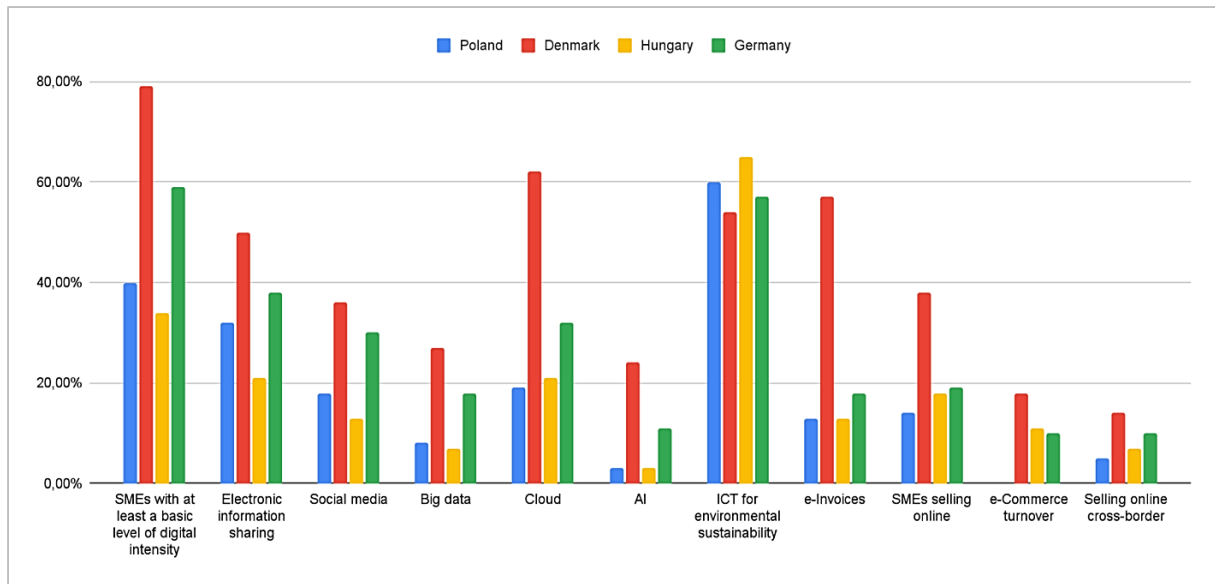


Figure 14. Comparison of the Polish and other selected European countries' digital economies in the use of digital technologies.

Source: own work, based on European Commission (2022b, e, a, d, c).

At the beginning, respondents were asked about digital technologies and services used in companies. In Poland, 88% of them use digital technologies and services, while in Denmark, 94% use digital technologies and services. In Poland, 12% do not use any digital technologies and services, while in Denmark, only 6%.

The second question that the respondents had to face concerned digital technologies, or more precisely, which digital technologies are most commonly used. In Poland, the most commonly used digital technology is electronic information exchange, which obtained 25%. Right behind it with a result of 20% was e-invoice. In third place is social media, which obtained 18% of all answers. Next, respondents used IT systems (16%), and the least popular were the data cloud (12%) and online sales (9%). In Denmark, the most commonly used technology is the data cloud with a result of 62%. The second most commonly used technology is e-invoice, which obtained 57%. Another technology that is often used by Danes is electronic information exchange (50%) and social media (36%).

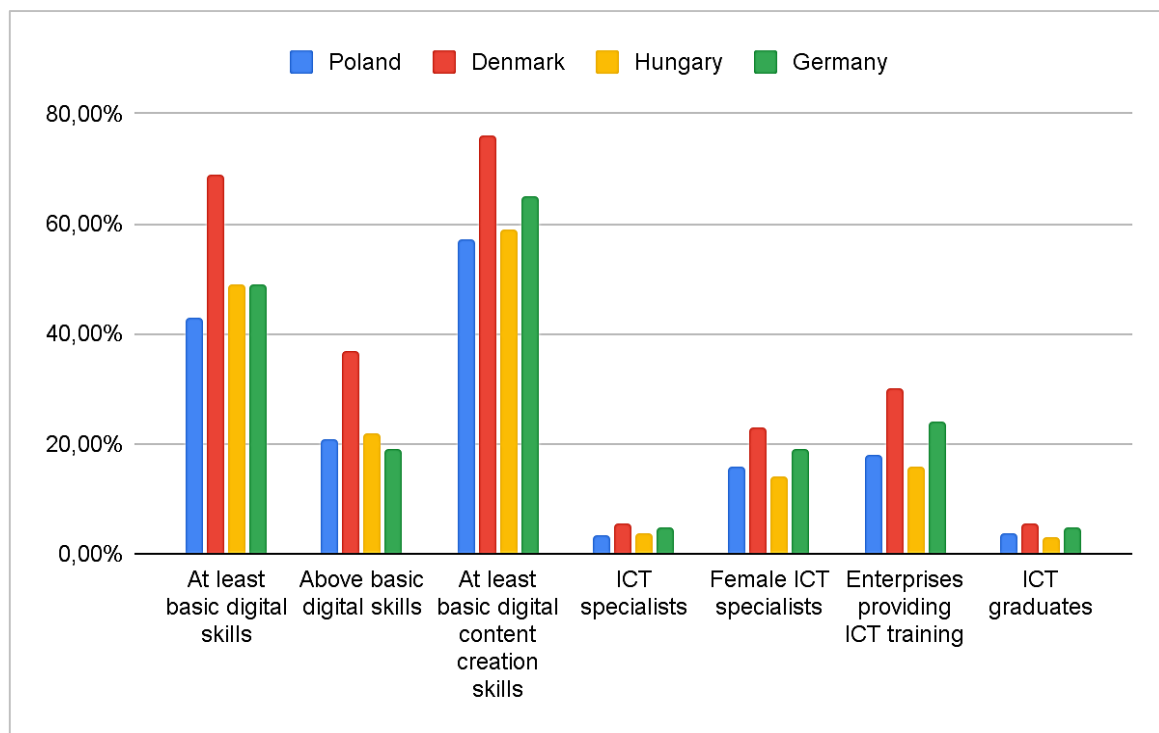


Figure 15. Comparison of the Polish and other selected European countries' human capital regarding digital skills.

Source: own work, based on European Commission (2022b, e, a, d, c).

The technologies chosen less often by Danes were IT systems (24%) as well as e-commerce (14%). It can be seen that Danes use digital technologies much more often and more willingly than Poles. The next question aimed to check the IT and digital skills of the respondents. In Poland, 60% of the people taking part in the survey have at least basic IT and digital skills, while in Denmark, as many as 76% have such skills. The intermediate level in Poland is possessed by 27% of the respondents, compared to Denmark, where intermediate skills are 69%. When it comes to high skills, in Poland, 13% of the respondents have such skills, while in Denmark 37%. A significant difference between these countries can be seen in the intermediate and high levels. This may be due to the fact that in Poland very few people take part in training that could improve the level of IT and digital skills. It is also worth mentioning that Poland is a country where the elderly population outnumbers the young, which is why there may be a reluctance to modern technologies, which affects the described results. To sum up, after the analysis, it can be stated that in Poland in terms of the use of digital technologies and services, it does not look bad, but the vast majority of digital technologies and services are still underused in order to develop the digital economy. Comparing digital technologies and services, Denmark is definitely better developed, as shown in Figure 14. It is encouraging that many people in Poland have at least basic skills. Unfortunately, in Denmark, a very large number of people, in addition to basic skills, also have intermediate skills. The Polish digital economy is still developing and in the near future should slowly climb up in the ranking of the Digital Economy and Society Index (DESI).

2.5.2. Comparison of the Polish and Hungarian digital economies

The comparative analysis of the Polish and Hungarian digital economy aims to show the difference and reasons that divide these two countries in the subject of the digital economy. In 2021, in the DESI ranking, the Polish digital economy was ranked 24th, while the Hungarian one 22nd, among the 27 EU Member States. The analysis took into account Hungary's data from the DESI ranking from 2021 and the responses of Polish respondents collected in 2022. 60 respondents from Poland took part in the analysis. The first question that respondents had to answer concerned the use of digital technologies and services. In Poland, services and technologies are used by as many as 88% of Poles, while in Hungary, the same figure is 83% of respondents. In Poland, 12% do not use any digital technologies or services, while in Hungary, it is 17%. The next question that the respondents had to face was to find out which digital technologies are used most often. In first place, the most frequently used digital technology in Poland is electronic information exchange with a score of 25%. In second place came e-invoice with a score of 20%. Right behind it is social media with a score of 18%. IT systems received 16% of all answers. The least frequently chosen digital technologies in Poland turned out to be the cloud (12%) and online sales (9%). In Hungary, on the other hand, the most frequently used digital technology turned out to be the cloud and electronic information exchange, which received 21% each. Ex-aequo with a score of 18% came technologies such as online sales and IT systems. The less frequently chosen technologies turned out to be social media and e-invoices, which received 13%. The respondents were then asked about their level of digital skills. In Poland, 60% of respondents declared a basic level, while 27% an intermediate level. Only 13% of respondents in Poland are advanced. Comparing the situation in Hungary: 64% of respondents have basic skills, and 33% have intermediate skills. 19% achieved an advanced level in Hungary. In summary, the collected information should be noted that when comparing Poland with the results of the 2022 survey and Hungary with the DESI ranking from 2021, it can be said that Poland has made a significant step towards improvement in terms of the use of digital technologies and services. It is worth noting that the technologies used by Hungary are at a very close level and there is no major fluctuation in the use of technologies, while in Poland one technology is used more often and the other very rarely. The IT skills of people in Hungary are comparable to those of Poles. When comparing the digital technologies and services of Poland and Hungary, it can be said that it will be a matter of time before Hungary overtakes Hungary in the DESI ranking.

2.5.3. Comparison of the Polish and German digital economies

The comparative analysis of the Polish and German digital economy aims to show the difference and the reasons that divide these two countries in the subject of the digital economy. In 2021, in the Digital Economy and Society Index (DESI) ranking, Poland ranked 24th, while Germany ranked 12th, among the 27 EU Member States. The analysis took into account German data from the DESI ranking from 2021 and the responses of Polish respondents collected in 2022. 60 respondents from Poland took part in the analysis. At the very beginning,

the respondents were asked whether they use digital technologies and services. In Poland, 88% use digital technologies and services, and in Germany 83%. In Poland, 12% of the people taking part in the survey do not use digital technologies and services, and in Germany 17%. The second question concerned the most frequently used digital technologies. In Poland and Germany, the most frequently used technology is electronic information exchange, which was obtained in Poland by 25% of all respondents and in Germany by 38%. The second most frequently used digital technology in Poland is e-invoice with a result of 20%, and social media are right behind it with a result of 20%. IT systems are right behind the podium with a result of 16%. Less frequently chosen technologies in Poland were the data cloud (12%) and e-commerce (9%). In Germany, the second most frequently used digital technology is the data cloud with a result of 32%, and right behind it in third place with a result of 30% are social media. Right behind the podium with a result of 18% are e-invoices. The least frequently chosen technologies in Germany are IT systems (11%) and online sales (10%). The next question aimed to check the level of IT and digital skills in both countries. In Poland, 60% of respondents had a basic level, while in Germany it was 65%. As for the intermediate level, it was obtained in Poland, 27% of all answers, while in Germany it was 36%. High skills were obtained in Poland by 13%, and in Germany by 19%. In summary, there are very large differences between the Polish and German digital economies in terms of the level of use of individual digital technologies. It is also worth noting the level of IT and digital skills, where Poland even has an advantage in terms of the basic level, but at the intermediate and high level, it lags behind Germany. Comparing the Polish digital economy with the DESI ranking for Germany from 2021, it can be said that Poland is increasingly involved in digital technologies, and over the course of a few years it may become a very serious country in terms of the digital economy.

3. Discussion

3.1. Identification of problems with the implementation of Industry 4.0 in the surveyed enterprises

The survey and the answers provided by the respondents show that various problems can be identified in companies. The main cause of problems that hinder the implementation of Industry 4.0 is the size of companies, because it affects the income and development of companies. Finances play a key role here due to the fact that not every company can afford to introduce Industry 4.0 technologies. In small companies, the issue of Industry 4.0 is quite averagely known, which may be related to the lack of knowledge about the Fourth Industrial Revolution and the technological progress that goes with it. They do not have a large budget, so any expense that would be associated with investing in this technology would have to be thought through twice before the company decides to make a given investment.

Some companies do not associate themselves with the development of Industry 4.0, because the way they operate on a daily basis is sufficient for them. It is also worth mentioning here that it will be more profitable for small companies to hire new employees instead of investing in new technologies. In medium and large enterprises, a large number of respondents were familiar with the issues of Industry 4.0, but there were still a few enterprises that had not dealt with the Fourth Industrial Revolution. Companies are quite willing to use, or would use, Industry 4.0 technologies. Some enterprises will not link their future with technologies, because they operate on an external application, and for some, it would involve a huge reorganization of the functioning of enterprises. For medium and large enterprises, it involves time and various procedures, which unfortunately cost them too much money to reorganize the given enterprises. Based on the identification of problems that have arisen in companies of various sizes, it would be worth proposing training for employees in order to expand their knowledge of the issue of Industry 4.0 and to present the benefits of implementing the Fourth Industrial Revolution technologies for companies. The training proposal will make employees aware of the wide possibilities of Industry 4.0 and the significant benefits that improve the implementation of activities that can be obtained from the implementation of Industry 4.0, in addition, it will present interesting benefits for companies that will be able to benefit from it in the future. Along with training on Industry 4.0, which is the basis for Industry 5.0, companies should also learn what other benefits they can achieve in the near future, having already introduced Industry 4.0 in their company, in order to later move to Industry 5.0 and thus continue to develop. A change that would be worth proposing is the gradual introduction of Industry 4.0 for their companies. All companies have the false impression that implementing Industry 4.0 involves a radical change in the way a company functions, and that it would be enough to divide it into several stages so that time is not wasted, and the company can continue to work for itself and earn money. It is said that companies lack the right approach to planning and optimizing processes, so gradual changes that would be divided into stages would significantly affect the way a company functions.

Enterprises, unfortunately, do not want to implement Industry 4.0 technologies due to the costs and the way their organization functions, which in their opinion is doing well without the Fourth Industrial Revolution. Generally speaking, enterprises that want to stand out on the labor market should invest in Industry 4.0 technologies, e.g. by taking out a loan and in this way try to implement the technology that would be most needed for their company at a given moment and see if it works over a few months, and then draw conclusions whether the investment was worth it. Enterprises should remember that other companies from the same industry that will introduce modern technologies will constitute greater competition on the labor market than their industry opponents that do not invest in any technologies, because in their opinion the company is functioning well and no company threatens them. Enterprises should strive to develop their companies and be as attractive as possible in their industry, overtaking their competition thanks to modern technologies.

3.2. Identifying the problems of the Polish digital economy

Comparing the Polish digital economy to countries such as Denmark, Germany and Hungary, one can see differences that distinguish Poland from the above-mentioned countries. The biggest differences can be seen in the use of digital technologies and IT and digital skills. Taking into account the digital technologies of all countries, it can be concluded that Poland uses only some of them to a significant extent, and some are used very little or in a negligible way. The role model in the use of technologies, which were presented in Figure EQ2, are very often used. Poland should follow the example of countries such as Denmark and pay more attention to the use of all digital technologies year by year and develop them step by step. It can be said that thanks to the development of digital technologies, Poland should develop very quickly, thus catching up with countries in the DESI ranking, thanks to which it will improve its place and the quality of functioning of the Polish digital economy. Another problem that the Polish digital economy is struggling with is the knowledge of IT and digital skills. The Polish digital economy should pay attention to the skills of society, because when compared to countries that are higher than Poland in the DESI ranking, it does not lag behind these countries only at a basic level. Taking into account the intermediate and high level, countries that are ahead of Polish society have a greater or lesser advantage. The problem with IT or digital skills can appear from the earliest years, where society is only taught basic skills. In later professional life, society is very rarely sent for training that would significantly improve the qualifications of employees and increase the number of people who would have intermediate or high skills.

4. Conclusions

The aim of the study was to analyze and assess the intensity of implementation of Industry 4.0 technologies in the digital economy of European Union enterprises, taking into account the identification of problems with the implementation of Industry 4.0 and the presentation of significant benefits resulting from the implementation of Industry 4.0 technologies in the surveyed organizations. The survey conducted among enterprises aimed to examine enterprises in terms of the intensity of Industry 4.0 implementations and to compare the development of the Polish digital economy with the European Union countries, which consequently allowed for the presentation of important conclusions:

1. Small enterprises have a rather average understanding of the issue of Industry 4.0, which is caused by a "shortage" of knowledge about the Fourth Industrial Revolution; additionally, small enterprises have a limited budget when it comes to implementing Industry 4.0 technologies.
2. It is more profitable to hire a new employee in small businesses than to introduce any Fourth Industrial Revolution.
3. Medium and large enterprises are much more familiar with the issue of Industry 4.0 and are more willing to use and apply Industry 4.0 technologies to increase productivity and market competitiveness.
4. The vast majority of small, medium and large enterprises will link their future with Industry 4.0 in order to modernize the functioning of their enterprise.
5. The lack of knowledge among employees of small, medium and large enterprises about Industry 4.0 issues and the benefits resulting from them affects the way a given enterprise functions and develops.
6. Polish companies are making decisive use of digital technologies and services at a level of 88%. In the future, this will influence the development of enterprises and the digital economy in Poland, which will affect the position in the DESI ranking.
7. Poland uses some digital technologies to a large extent, and some technologies quite rarely. These include additive manufacturing using 3D printers, IIoT, autonomous robots. This is due to the high costs that must be faced at the beginning.
8. The knowledge of IT and digital skills of employees is insufficient, taking into account the surveyed countries from the European Union, which is confirmed by the results of the conducted research.
9. Polish enterprises are increasingly using fixed broadband connections at a level of 85%, which was confirmed by the results of the survey.

To sum up, it should be pointed out that the conducted research has shown that Polish enterprises should follow the development of technology, and in particular the Fourth Industrial Revolution, because the development of the digital economy and Industry 4.0 itself are interconnected. The development of employees and the entire Polish society in digital and IT skills will bring a number of benefits that will later have an impact on the functioning of the companies they employ. Enterprises should pay attention to the development of Industry 4.0 technologies in their area, because in the future it will be associated with significant benefits. Additionally, the introduction of Industry 4.0 will be another facilitation for entering the era of the Fifth Industrial Revolution, the presence of which is certain in the near future. The digital economy and Industry 4.0 itself go hand in hand and it is only a matter of time and it depends on enterprises how they combine these two things so that their companies function properly.

5. Summary

The presented work describes the possibilities of implementing Industry 4.0 in small, medium and large enterprises, and also compares the digital economy of Poland to the countries of the European Union. Thanks to the analysis of the possibilities of implementing the Fourth Industrial Revolution, it was concluded that some enterprises are ready to implement Industry 4.0, but for some sizes of companies, the key factor that may limit the introduction of modern technologies is the initial costs, which for some companies are very high. For the vast majority of enterprises, modern technologies are very attractive and even the initially high cost is not a problem for them, due to the significant benefits that "come" with these technologies and the possibility of developing the enterprise, because in this way organizations strengthen their position and competitiveness on the market. Taking into account the comparative analysis of the Polish digital economy with EU countries, it can be concluded that Poland is increasingly developing in terms of IT and digital skills, although Polish enterprises use some digital technologies much less often, thus focusing only on some of them instead of using them much more often and developing digital technologies in this way. Industry 4.0 is a huge step for companies and logistics, which leads to the modernization of production in various companies, using modern information and communication technologies. Nowadays, the digitalization of companies and logistics processes is inevitable and it is necessary and should be more and more invested in modern technologies. At first, it can be very expensive, but in the end, it is very profitable in its resources, it has many modern technologies that can help companies develop their functionality and development and be more competitive on the market.

To sum up, Industry 4.0 will be eagerly implemented by Polish companies, thanks to the benefits resulting from the technologies introduced or being introduced, and the initially high cost will pay off very quickly. Additionally, it will make it much easier for companies to introduce Industry 5.0 to their operations. The digital economy is developing very dynamically and it is only a matter of time before it takes a higher place in the DESI ranking.

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