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Digitalization and its impact on labour market and education. Selected aspects

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Abstract
The main purpose of the article is to demonstrate the need for multidimensional professional training of employees for challenges related to the rapidly-developing digitalization, which consequently translate into the competitiveness of the economy. The theses presented in the article have been verified using: literature review, critical literature analysis, document research and comparative analysis. Based on this article, we can discuss a future in which man and the surrounding reality will depend on the rapidly-developing digitalization. This phenomenon may lead to a fading of the known world and the transition to a new one defined by technologies based on the flow of data and its analysis. However, knowledge will still remain important for such a change. It seems that the ongoing education system should be better connected with competencies allowing for changes that are taking place in the economic environment. The article demonstrates the importance of knowledge and provides an opportunity to exchange ideas in the vigorously-developing digitalization. Through the knowledge presented in the article, it can be concluded that the digitalization of the education system and labour market means revolutionary changes, incomparable with the objectives and scope of the existing measures.

Keywords Digitalization · Labour market · Education · Comparison

Mathematics subject classification 90B10 · 90B15 · 12-02

1 Introduction

The idea of the article is an attempt to present the impact of digitalization on education and the labour market. Technological progress changes the nature of work, affecting not only the organization of production but also social life. Technology

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becomes a source of competitive advantage when people are able to make use of it. Therefore, those responsible for making decisions in organizations should focus on competencies that enable individuals to make the best possible use of both already available and emerging technologies. Unlike traditional approaches that focus on job functions or job characteristics, competency-based human resource management helps identify outstanding employees. It can also be used to develop and select people with abilities (similar to the abilities of outstanding workers) to achieve the desired results. Another issue is universal globalization that will focus more attention on the issues of diversity, openness, knowledge, willingness to adopt changes, use of various distribution channels and more efficient organization of work on a global scale. To maintain a competitive position, developed countries must use the creativity and talents of their workers. In this regard, competency-based human resources management can prove useful, as it enables identification of outstanding employees and discovery of their potential source. There is already a strong interest in competencies and their importance from the perspective of maintaining competitiveness on the labour market. The literature as same as research findings confirm the need to note that digitalization should be perceived as a content in all social and personal declarations (Mosteanu, 2020). Thus, gaining knowledge is an important benefit of present-days.

Digitalization in the first quarter of 2019 year was a fundamental theme of such events as the World Economic Forum in Davos, Digital Innovation Hubs Day in Stuttgart, Mobile World Congress in Barcelona and many other conferences and debates. Alongside this trend of events, many scientists and experts, representing consulting companies and start-ups, publish reports describing the processes related to digitization, building in them a vision of their further development.

Poland is one of the most dynamically developing economies of the European Union, however in terms of technology it is behind, among others, the Czech Republic and Germany (Eurostat, 2019). This is not due to a lack of awareness of the importance of the role of technology in economic development, but to the structure of the economy and the place of Polish companies in value-added chains. Poland is a country that is dominated by very small companies, often operating on local markets for which technological investment is often too great a challenge. In addition, Poland is a country building a competitive advantage on low unit labour costs, and not on technological potential. That is why the use of digital technologies in Polish companies is still moderately low—for example, only every fourth company has an internal enterprise resource planning system (ERP), while in Germany almost 40% of companies have such a system. In light of this key problem, the article focuses on emphasizing the importance of digitalization in economic development, which is based on modern education and a labour market determined by full employment.

This article is organized as follows. Section 2 describes the data and methods. Section 3 reviews the literature and develops hypotheses. Section 4 presents the impact of digitalization on the labour market and education system. Section 5 shows how digitalization influences the labour market and education system in the Silesia Voivodeship. Section 6 concludes the study.

2 Materials and methods

In compliance with the principal purpose of the article, which is the analysis of the relations between digitalization and the labour market and education, various research methods were used in the research, including: analysis and criticism of literature (desk research), and dogmatic legal, statistical and comprehensive forecasts. The pointed research methods core mainly on cognitive areas, which are: digitalization, education and economic growth conditions of the Silesian Voivodeship, in the area of digitalization represented by contemporary challenges.

The analysis and criticism of literature tackled several pieces of complementary work and geared largely on the processes and megatrends specified by education and demographic, technological and macroeconomic changes, forming the state and development prospects of the labour market answering contemporary challenges. This analysis was conducted between March and July 2020. The principal objective of the method was to check the available public, scientific and professional literature, through which the analyzed problem area was examined. The conclusions and recommendations emerged from them are geared to boost the utilitarian part of the analyses carried out. The analysis and criticism tackled both theoretical publications and those discussing research results and forecasts in several cognitive cross-sections. In the process of determining the research articles to be analyzed, two searches were performed. First, the researcher explored the Web of Science, including ESCI, EBSCO Host, Educational Research Abstracts, Springer, ScienceDirect and ERIC electronic databases using combinations of Boolean operators. In relation to learning areas of digital transformation, various combinations of these operators were adopted as follows: (digital*) AND (transformation* OR Europe OR Poland OR Silesia). Next, the reference lists of the included studies were reviewed. This process is summarized in Fig. 1.

The analysis also used other studies committed to the development prospects with reference to strategic documents regarding the future. Contained in these documents were the multi-annual development strategies for Europe, the country (Poland) and the voivodeship (Silesia), in several quality sections. In addition to formal and legal issues connected with the development prospects of the studied areas, this comprised, in applicable law, the studies related to in the European and national documents in which medium and long-term goals and tasks in the field of economic and social policies were outlined, especially as part of the abovementioned ongoing and predicted demographic processes.

3 Digitalization—theoretical aspect

Digitization is defined in many aspects. Initially, with the development of computer techniques still in the 1950s, the term "digitization" was defined, meaning the processing of the material bed from the analog to digital form by scanning or photographing (OED, 2015). The acquisition of the digital form

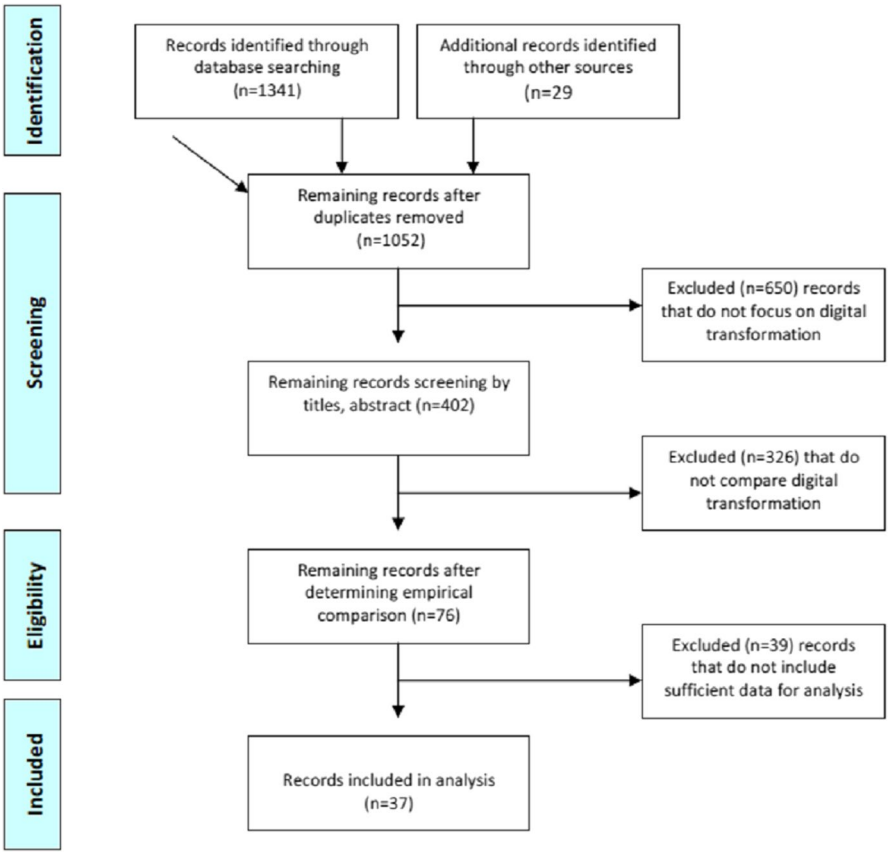

Fig. 1 Flow diagram of the study selection

of the object is also accompanied by other processes related to the creation of various types of metadata, as well as the collection, structuring, processing, archiving, management, exchange, protection and use of materials and data. In connection with these processes, the term *digitization* has actually been replaced by another broader term, which is *digitalization*. This term is nowadays widely used to refer to the adaptation and growth in the use of digital and computer technologies by organizations, economic sectors, and countries etc. (Brennen & Kreiss, 2014). In the following study, the term digitalization is used.

Continuing, it is worth noting that the digital transformation of various spheres of business activity is a response to the challenges associated with the rapid development of digital technologies. Digital transformation is a special kind of organizational change in the enterprise, sector, supply chains, functioning of public administration and entire economies. In a report prepared in 2015 by the consulting company Roland Berger at the request of the Federal Association of German Industry (*Bundesverband der Deutschen Industrie eV*.—BDI), based on a study of

key sectors for the German and European economies, four key determinants of the digital transformation process were identified, which are: digital data, automation, connectivity and digital customer access (Berger, 2015; Korzeniowski et al., 2016). With this in mind, the following hypothesis is developed:

H1: The Silesia Voivodeship possesses key determinants of the digital transformation process.

Various sectors of the economy are heterogeneously vulnerable to digital transformation and, at the same time, threatened by developments of digital technologies. According to the research conducted among senior management in the spring of 2015 by *the Global Center for Digital Business Transformation* (Bradley et al., 2015), by 2020, digitalization could oust around 40% of companies currently with a strong position in their sectors from the market. According to the *Digital Vortex* report, these industries are the most active in the virtual world embedded on the Internet connecting e.g.: inhabitants, objects, data and processes used to digitally exchange values (Bradley et al., 2015). However, the least susceptible to digital transformation include: the oil and natural gas sector, the pharmaceutical sector and the utility sector (enterprises from the energy, gas, heating and water and sewage sectors). Hence, the following second hypothesis is formulated:

H2: The Silesia Voivodeship is positively associated with digital transformation.

As the literature indicates, digitalization in the economy is closely connected with a developed ICT sector in a given country and the level of Gross Domestic Product (GPD) produced by that sector in the country. Subsequently, it is also connected with the number of those working in this sector and associated industries. In another approach, digitalization can be seen through the prism of dissemination of new technologies and ways of communication and optimizing their usefulness in all sectors of the economy. Hence the following conclusion can be drawn. Currently, the ubiquity of digitalization is a vital condition for the development of all human activities. Therefore, the last hypothesis is:

H3: Digitalization has an impact on the labour market and education in the Silesia Voivodeship.

In this context, it is worth noting that there are numerous concepts describing and analyzing the digital economy. According to the concept of the US Census Bureau (Mesenbourg, 2003), the digital economy can be analyzed in three dimensions: infrastructure *(hardware, software*, telecommunications networks, etc.), e-business (the way companies do business – the more processes that are managed via the network, the more digital the company and the industry) and e-commerce (transfer of goods to customers and contact the seller makes with them, e.g. when someone buys a book online) (Tapscott, 1995). The boundaries between these three dimensions disappear in the world of the virtual economy, sharing economy and social media.

PricewaterhouseCoopers (PwC) in their reports concentrate on the six dimensions of development of the digital services market, which are: ubiquity, affordability, reliability, speed, usability and the ability to use them (Sabbagh et al., 2012). In another statement, PwC suggest using the following indicators for researching e-economy: digital input (information input), digital processing (how far different processes in enterprises are integrated); digital output (how far the digitalization of previously entered information is related to sales) and infrastructure (the level of sophistication of the technologies used) (Gröne et al., 2011). In turn, *Boston Consulting Group* (BCG), in one of the author's papers (Zwillenberg et al., 2014), by analyzing 55 different indicators focused on the change in business models (Gumsheimer et al., 2015) which is triggered by new technologies. Yet another report, on sectors of the economy, chose digital indicators describing the maturity of the industry, estimating the use of *Information and Communication Technologies* (ICT) in relations with customers, used in the production process and the impact of digitalization in the future. On this basis, it evaluates the development perspectives of the examined economic sectors.

In conclusion, based on the above comments, it can be assumed that digitalization is not a homogeneous process. It can be seen through the prism of changes taking place in the globalized economy, their impact on the whole of human activity in the surrounding space and in the foreseeable future.

4 Digitalization and the labour market and education

For several years, we have witnessed another turn, with the final form as yet unknown, which is associated with innovative digital solutions (digital disruption). While the world of digital transition meant a harmonious and synergistic development of information and communication technology and operating their services or processes, so much digital disruption is associated with the huge, sometimes reaching the foundations of our actions—with the nature of discontinuity, influence of advanced technology in traditional solutions, practice or activity (Adams, 2018). As many researchers note, the disruption changes our culture, questions the values recognized for years, affects trade markets, creates new, previously unknown communication channels—in short, it significantly changes our civilization environment (Chinoracky & Corejova, 2019; Głąb, 2016; Sadovaya, 2019).

In 2015, the global ICT market value was estimated at EUR 2,962 billion, and has since steadily grown (Idate DigiWorld, 2019). It is expected that in 2021 its value may exceed EUR 4,000 billion (Idate DigiWorld, 2019). At the same time, in six years (2015–2021) the value of revenues from Internet services is to be doubled (Idate DigiWorld, 2019). In Poland, ICT is one of the fastest growing sectors of the economy. It is responsible for about 8 percent of GDP and one-third of employment in the modern business services sector. The ICT market value in Poland is estimated at PLN 42.2 billion (EuroLinux, 2018).

Despite such a large development of the ICT industry in Poland, examples of using digital disruption to carry out social or business changes are relatively rare—one can only mention the creation of mechanisms characteristic of the

crowdsourcing model, used to raise funds for charity. Symptoms of changes taking place in this model include the emergence of a market for paid online content (newspapers, e-books, audiobooks), the emergence of paid channels (Netflix, YouTube), building global passenger transport brands (UBER, Flixbus) or "alternative hospitality" (Airbnb). These are global changes, introducing a new cultural and technological model of social and business activity, which also strongly affects education.

Competence describes a person's capability to do something adequately, or a person's mental capacity to understand the proceedings of a trial. Competence is the noun form of competent, which is an adjective (OED, 2023). It includes, therefore, both skills and qualifications of person.

Most European comparative research of digital competencies level, including Eurostat (European Commission, 2019), uses personal statements of respondents regarding their level and use of computers or the Internet. Unfortunately, these studies reveal that in 2017 more than half of the Polish population was characterized by low or no digital competency. About 20 percent of Polish women have never used a computer, and over 20% the Internet. The described state in the last five years—according to studies—has improved. It is worth mentioning that in 2012 every third Pole did not use a computer and the Internet. Despite this, in this respect Poland still stands out from the EU average, where the percentage of people who never use computers was over a dozen percent (European Commission, 2019). Research has also shown that the factor that most strongly affects the level of declared digital competencies is the age of respondents. In the group of people aged 55—64, only every fifth person uses a computer and the Internet, and only a few percent have secondary competencies. In turn, among young people only over a dozen percent have low competencies.

Eurostat data indicate that the level of computer and Internet use by Poles for the implementation of professional activities at work is growing quite rapidly. At the same time—as in previous results—it is still much lower than the European average, which is additionally underestimated by several countries with little innovative economies (European Commission, 2019). Eurostat results, which show Poland at the end of the European rankings, are indirectly a confirmation of the results of other studies on the digitalization of the Polish economy. They point to the growing demand for digital skills, e.g. Balance of Human Capital (Kasparek et al., 2017), and *eSkills for Job Index* study (KIGEiT, 2016), and the growing digitalization of the economy itself e.g. Time to accelerate Digitalization of the Polish economy (Arak & Bobiński, 2016), and Development Perspectives of the Polish ICT Industry until 2025 (PARP, 2017), which depends on acquiring new specialist staff. According to the results of research, the Polish economy is not properly using the potential development of digital transformation processes. In this respect, we are still less evolved than many of the European countries. This is confirmed by the Economy and Digital Society Index of the European Commission (European Commission, 2019), calculated on the basis of indicators regarding human capital, coverage and level of development of electronic communications infrastructure, intensity of Internet use, implementation of technologies and digital public services.

But—as previously noted—more than half of Poles are people born in the Internet age, and the percentage, for obvious reasons, will grow in the coming years. It

is surely that most pupils at this moment starting primary education will be working in new types of professions that do not yet exist (Gordon, 2013; European Commission, 2017; Holland & Brewster, 2021; Susskind & Susskind, 2022; Zahidi, 2023). Especially the ongoing education system should be better connected with competencies allowing for changes that are taking place in the economic environment. As well it need to be prepared to offer interesting forms of raising their level throughout their lives. It is anticipated that schools, colleges and universities will have to respond to the needs and expectations associated with changes in the demand for qualified staff in the labour market and to respond to the needs submitted by future students. Today, every learner has many educational options available in the world of the Internet, and these resources will grow dynamically. Huge resources of educational content made available in open platforms, e.g. online vocational training, advanced university courses—offered by universities with a global reputation—will allow everyone to choose the most suitable form of education. Another example consists of short training forms lasting several minutes, adapted to the needs of smartphone users and the model of use (e.g. on the way to school or work) offered by commercial training content creators.

Thus, educational choices will depend on individual life goals consistent with the preferences of generations. In this context, it is worth noting that Generation Z (born between 1995 and 2010) and the Alpha Generation (born after 2010) are mentally, socially and culturally different from Generation Y (born between 1980 and 1995) and earlier generations (Tafonao et al., 2020; O'Neill et al., 2020; McCrinde & Fell, 2021; Mironova et al., 2022). The freedom of personal choice, conditioned by current needs, and often also by the requirements of the current employer or demand on the labour market, will force diverse and rapidly evolving forms of the educational offer of various public and private entities, focused on the acquisition of practical experience and skills. Currently, they are increasingly implementing new education techniques due to:

- organizational forms (e.g. *Professional Learning Communities* (Wikipedia), *Learning Circle* (Wikipedia)
- educational model (e.g. pedagogy of the place (Wikipedia), "service-based learning"(Wikipedia)
- teaching methodologies (e.g. The design method—co-creation, *design thinking,* reversed class (Wikipedia)
- model of using digital tools and content (e.g. BYOD—*Bring Your Own Device* (Laboratorium Dydaktyki Cyfrowej, 2016), and in particular the integration of students' private smartphones into teaching processes)
- training resources (e.g. Mooc—*Massive Open Online Courses* (Wikipedia), *Apple Textbook Initiative* (Apple.com)
- platform support education (e.g. *ITunesU* (Apple.com), *Google Classroom* (Google.com)
- university courses (e.g. *edX* (Edx platform for education and learning), *OCW* (MIT open course ware)
- standardization of programs and educational content (e.g. *The Common Core Adoption* (Wikipedia)
- use of social media in education (e.g. *Facebook* (Aleksandrowicz, 2014).

In the next decade, digitalization may lead to a new phase of changes related to the business profitability associated with advanced robotic solutions and artificial intelligence. Experts forecast the proliferation of robots not only in factories, but in the immediate vicinity of man in the workplace, at home, and on the street. As a consequence of 5G technology, the world of digital devices can move to the world of interconnected network devices. The result will be a new type of industry development and quality of life related to *big data* management (Raczko, 2015) and creating business algorithms. Solutions known today based on computing clouds will revolutionize the provision of digital services and, at the same time, change the business models of these services (Raczko, 2015).

Reaching the maturity of the twenty-first century technologies (5G, Internet of things, big data, cloud) and the development of artificial intelligence bring groundbreaking educational challenges. There will be changes in existing habits, living conditions, dominant forms of activity, interpersonal relations and forms of contact with the surrounding environment. Some of today's professional information specializations will enter history, while new ones will emerge. In this light, it is important to emphasize that the digital transformation of our time generates a need for competencies that go far beyond the sphere of IT, computer or application knowledge and skills that were needed in the era of computerization. Specialist competencies specific to the IT profession are undoubtedly most expected (in 2017, the average salary of a full-time IT specialist in Poland was two and a half times higher than the average salary in the country, while the deficit of specialists in this professional group was estimated at 50,000 people), and the largest importance in the scale of social pro-development are known functional digital competencies.

Digital transformation processes are a significant issue for the Polish economy, labour market and education. As numerous studies show, Poland's position in the world relies on its ability to meet them (Górniak, 2015). There must be progress in this area. For the Polish education system, digitalization means a revolution that is incomparable with the objectives and scope of previous education and higher education reforms.

5 Digitalization and its impact on the Silesia Voivodeship economy in comparison with the Mazowieckie and Małopolskie Voivodeships

The Silesia Voivodeship has a population of nearly 4.5 million people, which is 11.8% of the Polish population and is the most urbanized Polish region (76.0% of the urban population) and has the highest population density in the country (357 people/km^2 where the national average is 122 people/km^2). In terms of population, the Silesia Voivodeship comes second in the country after the Mazowieckie Voivodeship (14.5%) (GUS, 2022). The data enabling the comparison of the Silesia Voivodeship with the country and the most populated Polish voivodeships is presented in Fig. 2.

An example of the development of the digitalization process in the Silesia Voivodeship may be the widely perceived telephone communications system. Silesia has significantly transformed in recent years. Clear progress in the area of mobile telephone development is accompanied by a decreasing number of landline

	Silesia	Mazowieckie	Małopolskie	Poland
Population (in millions)	4.4	5.5	3.4	38
Population (people per 1 km^2)	357	155	226	122
Urbanization rate (in %)	76.0	64.6	47.9	59.8
Landline phone subscribers (in millions)	0.4	0.6	0.3	2.9

Fig. 2 Silesia Voivodeship compared with the country in 2021. Source: (GUS, 2022, 492–495)

telephone subscribers. In 2021 in Silesia, the number of subscribers to cable telephones totaled 376.6 thousand, which accounts for more than two-thirds of the state in 2002. In turn, the number of households that have a cell phone increased in 2003—2021 from 43% to 97.1% (in Poland this ratio reached the level of 95.0%) (CBOS, 2022). In recent years, there was also a rapid increase in the number of Internet users. In 2021 in Silesia, 93.6% of existing households (2nd place in the country) had Internet access. The national average was 92.4 (GUS, 2022).

In the Voivodeship, access to electronic services on regional digital platforms is increasing (such as: e-PUAP, SEKAP, EDU SILESIA, and SILESIA INFO). In 2017, 98.8% of offices had electronic registry boxes, which were more often used in the local administration than state offices (GUS, 2018). In addition, the Voivodeship had the largest number of offices equipped with an electronic documentation management system (79.3%) (GUS, 2018, p.50), second place in the country (Poland 59%) (GUS, 2018, pp. 39–40). In light of these circumstances, it is worth noting that over 70% of the units offering e-services indicated that the use of the Internet in the process of providing services has contributed to the shortening of its implementation time. Nearly half of them considered the increase in the number of services provided electronically an advantage.

The development of modern enterprises is inextricably linked to the achievements of ICT. Companies commonly use computers with broadband Internet access. The dynamic increase in the use of the Internet in business results from its significant features, such as: no bureaucratic restrictions, the possibility of international collaboration of specialists, global reach and widespread use. Through this, the Internet has become a business tool for buying and selling, exchanging information, financial settlements, promotions, and searching for suppliers, i.e., building competitiveness and improving efficiency. In the era of broad development of ICT, information and knowledge acquired through it becomes a strategic product. The ability to obtain information and transfer it via the network often decides on the company's success on the market, as well as creating broad opportunities for business contacts and conducting transactions. The improvement of work and the use of modern technologies is inevitably connected with equipping enterprises with computers. In the Silesia Voivodeship, 96.1% of enterprises used computers for their work, and 95.4% of enterprises had access to the Internet (with the national average of 96.2% and 95.6%, respectively) (GUS, 2018, pp.54–56).

The progressive robotization of services and industry is noticeable through the constant development of information technology. Industrial robots are increasingly used in various areas of the economy. They are used to increase the precision, speed and efficiency of enterprise production and services. Through robotization, arduous and dangerous work stations are served by machines, which positively affects the optimization of employment. In 2018, 6.4% of enterprises in the Silesia Voivodeship used them to work (with the national average of 6.3%) (GUS, 2018, p.89). Regarding the type of business, industrial processing companies most often used them, with the least often being companies dealing with the production and supply of electricity, gas, steam and hot water. Taking into account the type of device, service robots were most often used in enterprises related to administration and support activities as well as the repair and maintenance of computers and communication equipment, while industrial robots were used in industrial processing.

Another essential element of businesses digitalization is the use of *BigData* analysis, cloud computing and social media. BigData analysis consists in generating data by activities carried out electronically or as a result of communication between devices (M2M machines). Conducting big data analyses refers to the use of techniques, technologies and software to analyze large volumes of data obtained from an enterprise or other sources. These volumes enable more efficient management of processes in the company and better satisfaction of customer expectations. The knowledge provided by big data allows for precise personalization of the offer addressed to specific customers. This technology is an excellent tool that can significantly improve this process. In the Silesia Voivodeship, big data analysis is used by 7.6% of enterprises, which places it in sixth place in the country (GUS, 2018, p.92). Cloud computing, on the other hand, enables recipients to use various solutions of information and communication technologies in the form of services available through ICT networks, mainly the Internet. Cloud computing is currently becoming an interesting alternative or supplement to existing forms of acquisition and operation of solutions and tools in the field of information technology (IT) in enterprises. In 2018, 11.5% of enterprises benefited from paid cloud computing, mainly employing over 250 people and operating in the IT sector (GUS, 2018, p. 83). In turn, social media are a tool increasingly often used by enterprises in their business activities. They are mainly used for marketing purposes as well as for cooperation with clients or business partners. The percentage of enterprises using social media is steadily growing. Every third enterprise uses them in the Silesia Voivodeship (in Poland 30.3% and in the EU over 47% of enterprises) (GUS, 2018, p. 81).

In the context of these positive phenomena, it should be noted that, in the Silesia Voivodeship, there are areas not covered by broadband infrastructure (so-called white areas) (Regionalna Strategia Innowacji Województwa Śląskiego na lata 2013–2020, 2012), causing difficulties in the digitalization of the economy. The most difficult situation occurs in the northern and southern subregions.

To sum up, the digitalization process is developing very dynamically in the Silesia Voivodeship. As confirmed by the statistics cited above, the Silesia Voivodeship is the national leader in this area. The awareness that digital competencies and their possession are nowadays imperative for development determines the Voivodeship's

innovation and modernity. This is fully confirmed by the entries of strategic documents crucial for the Voivodeship's development (Program dla Śląska, 2017).

6 Conclusions

As has already been noted several times—digital transformation processes are a major challenge for the Polish economy. The country's position in the world depends on the ability to adopt and develop them. Digitalization of the national education system and the labour market means revolutionary changes, incomparable with the objectives and scope of the existing measures. In this context, it is worth noting that conservatism, and to some extent awareness of minimalism, which can be observed in the implementation of digital solutions for nearly two million Polish companies from the SME sector, appears to be largely the legacy of the Polish system of education. It is still based on institutional, methodological solutions and resources closer to the economy of the twentieth century, and sometimes even older. Groundbreaking technological solutions and their implementation are interdisciplinary and are increasingly often the result of implemented agile processes. On the other hand, school and university curricula are still created within traditional academic disciplines and on the foundation of theoretical knowledge, with rare references to the use of knowledge in practice (Głąb, 2016).

The purpose of the article was to demonstrate the need for multidimensional professional training of employees for challenges related to the rapidly-developing digitalization of the economy. Three hypotheses were formulated. The results indicate that all of them are supported.

The Silesia Voivodeship possesses key determinants of the digital transformation process. It is a clear leader in terms of investment attractiveness in Poland. Its biggest assets are very extensive labour resources, the second largest sales market in Poland, very high activity of the region towards investors, as well as a very well-developed economic and social infrastructure. With regard to the three categories of investments: industrial, service and advanced activities technologically, as in the general case list of investment attractiveness of Polish voivodeships, Silesia is also a leader. Its degree of economic infrastructure development is the result, above all, of dynamic special operations economic zones (SEZ) and a well-developed research and development sector (R&D). Comparing the data on the number of students in the largest Polish cities per 1,000 inhabitants, Katowice ranks second (177), just behind Poznań (191). In the analyzed cities, the smallest share of students per 1,000 inhabitants is in Gdańsk (136) and Warsaw (122). The data show how important the Silesia region is for students as well as employees. As Beata Białowąs (2022) noted, the coronavirus pandemic has changed our mentality and approach to digitalization, and has accelerated certain processes in administration. The nature of our work has changed, the way we use tools, software and hardware. Digitalization means modernity, but also threats, which we must not forget. The Silesia Voivodeship has huge potential in the field of new technologies, we must skillfully support innovative companies and give them a chance to spread their wings.

The Silesia Voivodeship is positively associated with digital transformation. It focuses on two directions: diversification and modernization of local economies addressed to business and limiting the negative effects on the labour market. Five components relating to the assumptions of transformation (JT) are included. The first, covering the economy, is to support research and development—total investment in companies and the R&D sector, mainly supporting the needs of the digital green economy and smart specializations of the region. The Silesia Voivodeship also wants to use JT funds to support entrepreneurship and competitiveness—through investments in the SME sector, especially in the part requiring diversification of products and services, e.g. provided to the coal and coal-related sectors. It intends to invest in terms of improving the competitiveness of enterprises and generating jobs, developing start-up activities, e.g. in post-mining areas, or developing infrastructure for entrepreneurship. Other assumed directions include digitalization and automation of production and service processes in enterprises, as well as activities for the circular economy—reducing energy and material consumption of production and logistics processes, increasing product reuse, recycling and resource efficiency.

Digitalization has an impact on the labour market and education in the Silesia Voivodeship. The Voivodeship, by eliminating infrastructural obstacles and regulatory barriers, ensures a more friendly climate for the inflow of new foreign direct investment (FDI). This, in turn, affects the development of technology as well as know-how transfer regions where the zones were established. They also have a positive impact on the development of valuable skills (e.g., marketing or distribution) and the popularization of modern managerial techniques. There is an increase in interest in digital transformation training, both among students and organizations, for which tailor-made studies are also organized. The consulting service in question, consisting in preparing an analysis of the development needs of the company in the area of digitalization is dedicated, also in a closed formula, to a specific company, adjusting the thematic scope to the realities of the industry. Digital technologies created in the ICT sector will enable a reduction of almost ten times more CO2 emissions by 2030 than the carbon footprint of this sector in the same period. Among the technologies that will play a major role in the green transformation, we can mention artificial intelligence used in autonomous cars, the concept of the Internet of Things and microelectronics.

The state described above implies the following view. Intellectual capital is an important factor in the development of the information society and, consequently, the knowledge-based economy. This capital consists of all intellectual values, practical experiences, skills and knowledge of residents as well as public and private organizations. It is the raising of the level of competency and skills in the use of ICT techniques, through various forms of training, and the improvement of the skills of individuals and organizations in the field of using the potential of new technologies that determine the creation of the information society. An indispensable fulfillment and a kind of stimulation of social and economic development is a wide range of high-quality services provided electronically, including: e-administration, e-business, e-healthcare, e-transport, e-education, and e-culture. For these reasons, in the era of a globalized economy, it is important to promote and develop the

possibilities of using information techniques in everyday life and activities, and to minimize the marginalization of those at risk of so-called digital exclusion.

This study can be further explored to be used for a more efficient combination of skills and key competencies of participants in the digital economy, as well as the needs of the education system. The next study is expected to include surveys, with a cross-nation analysis, allowing the establishment of the barriers and determinants of multidimensional professional training of employees for challenges related to the rapidly-developing digitalization.

Abbreviations Airbnb: Alternative hospitality; edX: Free Online Courses by Harvard, MIT and more; ERP: Enterprise resource planning system; EU: European Union; FDI: Foreign Direct Investments; GPD: Gross Domestic Product; IT/ICT: Information and Communication Technologies; JT: Just Transformation; MOOC: Massive Open Online Courses; OCW: Open Course Ware by MIT; MIT: Massachusetts Institute of Technology; 5G: Fifth Generation of Mobile Network

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Declarations

Competing interests The author declares that he has no competing interests.

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