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## Analysis of Enterprises' Readiness in for Industry 4.0 Implementation: The Case of Poland

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**Abstract:**

**Purpose:** The paper aims to analyze the readiness of enterprises in Poland for industry 4.0 implementation with taking into consideration its barriers as well reasons of implementing industry 4.0.

**Design/Methodology/Approach:** The research was conducted by means of diagnostics opinion CAWI (Computer Assisted Web Interview) questionnaire. The research was conducted by means of diagnostics opinion CAWI (Computer Assisted Web Interview) questionnaire among 40 respondents (owners/employees) of enterprises located in various regions of Poland.

**Findings:** Entrepreneurs clearly indicate their fears, but also the opportunities that such implementation brings with. During the research, many entrepreneurs were afraid of costs, even before the initial cost-effectiveness analysis of the implementation. Low social awareness of what industry 4.0 is the reason why it is not understood and implemented in a limited way. It also shows the power between the understanding of the principles of industry 4.0 and its visible manifestations in the enterprise. The dependencies shown by the conducted study were also analyzed. The strength of qualitative and qualitative relationships is shown by the Pearson C coefficient, showing which of the factors has an impact on the studied enterprises.

**Originality/Value:** The study also showed that implementation is not dependent on financial outlays but on the involvement of employees and middle management, which may indicate that it is treated as an industry challenge and depends on the company's readiness for implementation. The results of this article may serve as the basis for future research.

**Keywords:** Industry 4.0, technology, company, Industry 4.0, management engineering.

**JEL Classifications:** O33, O35, O39.

**Paper type:** Case study.

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## **1. Introduction**

Over the last few years, the industry 4.0 revolution has attracted more attention all around the world. Industry 4.0 has been considered a new industrial stage in which several emerging technologies are converging to provide digital solutions, it will provide opportunities for improving economic development, the transition to the digital economy, the ability to store information, and the unlimited possibilities to access knowledge (Dalenogare *et al.*, 2018). The concept of industry 4.0 is intended to help manufacturers in responding to individual customer requirements, and also link this to the growing needs of increased productivity and efficiency. It also aims to build cooperation between people and machines, creating a community, a system that reduces errors. Under concept 4.0, science, technology and society are in a cyclical relationship and interact with each other. In the near future, probably technologies that automate part of the human intellect and emotions will then become the basis for development. In this society of the future, people and machines will work in cooperation, purposefully, and harmony. This branch of industry activity also brings challenges and threats. To facilitate the creation of this type of industry, machines are manufactured using technologies based on the use of fully scalable, increasingly open automation solutions. Digitization, however, concerns the entire life cycle of these products.

Research carried out by German, Lucas, and Dalenogare (2019) showed that the implementation of the base technologies is challenging companies, since big data and analytics are still low implemented in the sample studied. As noticed by Pacchini, Lucato, Facchini, and Mummolo (2019) the implementation of industry 4.0 concept has further consequences for management and future jobs through creating new business models as well as a great opportunity for development and improvement in competitiveness, although the state of preparations for its implementation varies widely depending on the country, sector, or even an individual company.

In the concept of Industry 4.0, cost reduction, improvement in performance and also offering improved products and services, taking into account the preferences and behavior of consumers are to be achieved due to the automation of production based on the use and exchange of data in real time, using artificial intelligence (Pieriegud, 2016; Androniceanu, 2017b). Industry 4.0 is expected to transform production from isolated and independent cells to fully integrated, automated, and optimized process flow, leading to great improvements in the overall productivity, efficiency, and sustainability of business operations (Sahal, Breslin, and Ali, 2020).

## **2. The Level of Enterprises' Readiness to Implement Industry 4.0 – Literature Review**

The level of readiness for industry 4.0 differs from one country to another and this depends on the different perception of the idea of industry 4.0 in terms of the

available technological level and available resources, there are nine basic requirements if the industry becomes more ready (cooperative robots, auxiliary manufacturing, augmented reality, simulation, systems integration, Internet of things, cloud computing, cybersecurity, big data) (Lucato *et al.*, 2019). The ability of companies to keep pace with rapidly evolving technological developments will make them more prepared to implement Industry 4.0 in addition to cost advantages, proximity to customers and requirements for local content. The more the state is able to restore its existing industry abroad and return it inside, it will be more prepared for industry 4.0 because it will achieve integration between all types of industries and avoid transferring industrialization abroad and the use of new technologies such as automation and robots.

Relying on cyber systems, integrating virtual and physical manufacturing systems, shortening new product development times, increasing individual demands, increasing the need for flexibility in production, increasing decentralization to face rapid decision-making, increasing resource efficiency, increasing process automation, increasing digitization in manufacturing and continuing to reduce electronic devices by adopting nanotechnology to produce smaller electronic devices (Stentoft *et al.*, 2019). Likewise, willingness to meet customer needs, attention to product quality, increased automation, workforce readiness, the intensity of creativity and production processes will be more sophisticated (Schumacher *et al.*, 2016), and the quality of information and communication technology will increase the country's readiness to implement industry 4.0 (Nick and Pongrácz, 2016).

The readiness for Industry 4.0 is the availability of both the Internet of Things, which is through communication and interaction between physical objects with each other through various technological methods, Reducing the human factor, enabling devices to communicate with each other through smart networks, and for the percentage of disconnected objects in the future to be very low. And that the services internet is available through communication between the services and the internet, such as providing advice and providing after-sales services. In addition to the availability of cyber physical systems that act as a bridge between the real and virtual world and as a result of globalization and information exchange with cyber systems, future simulations of companies will be more effective with cyber physical systems (Ozturk and Koseoglu, 2018).

In order for companies to achieve complete readiness for Industry 4.0, they must implement a mix of new information technology and Internet of Things technologies, new transportation, and handling technologies as well as new materials and related processes (Basl, 2018). Companies must be fully prepared to implement Industry 4.0 to remain competitive in the market, and the integration of information technology and automation must be achieved to gain more sectors in the market, training employees to be able in the future to work with robots to perform complex tasks, and the ability to work on cyber physical systems, use software to analyze and collect data (Brozzi, D'Amico, and Monizza, 2018).

Industry readiness 4.0 also depends on the complexity of the production process, the degree of automation, the intensity of creativity for the workforce, the availability of modern and targeted working conditions for the development and application of technologies (Viharos, Soós, Nick, Várgedő, and Beregi, 2017). Industry readiness 4.0 is "People knowing technology and how to benefit from it" and "Improving the ability of machines and devices to connect to the Internet" are the most important factors in achieving all objective measures. In addition, to prepare for industry 4.0, it is necessary to have harmonic operability, visualization, decentralization, real-time power, service orientation, modularity. Also, technology readiness is an important step in preparing for industry 4.0 and includes, improving and developing the internet system, human knowledge of technology and how to use it, improving the ability of machines and devices to connect to the Internet, the ability to manage big data, exchanging data between or within organizations, developing data security systems (Samaranayake, Ramanathan, and Laosirihongthong, 2017).

### **3. The Barriers to Implementing Industry 4.0 in Enterprises**

In order to meet industry 4.0 challenges, employees must increase their flexibility in the way they see working time, wages, tasks, and workspace. In the age of technology and digitization, employees must maintain their skills and knowledge related to new technology. Among the challenges that Industry 4.0 faces are the lack of individuals who have high expertise to deal with industry 4.0 technology and this is one of the obstacles to its application, so individuals who are able to deal with complex technology in the future must be prepared. Likewise, when today's children grow up, a large percentage of them may not find jobs in the future because of industry 4.0 technology, and this is an obstacle to the application of industry 4.0 is its lack of acceptance from some societies due to fear of losing jobs (Man and Man, 2019).

"The lack of a digital strategy and the scarcity of resources" is the most prominent barrier in both developed and developing economies, and this requires government intervention to overcome these barriers, in addition to conflicts between workers due to changing work environments, lack of financial resources, poor data security, low degrees of standardization, misunderstanding integration, and poor systems structure are also among the main obstacles to the implementation of industry 4.0. In addition to that some European countries (such as Romania, Denmark, Hungary, and Sweden) were unable to achieve digital readiness, lack of knowledge about industry 4.0 and focus on the costs of developing the company and lack of understanding of the strategic importance of industry 4.0, which is one of the most important obstacles facing small and medium companies.

For example, in Romania, it suffered due to the lack of sufficient maturity for the digital transformation to adopt industry 4.0, and also the presence of organizational resistance by employees, and the lack of organizational vision towards this transformation, which is an additional obstacle (Weking, Stöcker, Kowalkiewicz,

Böhm, and Krcmar, 2019). A number of researchers such as Türkeş, Oncioiu, Aslam, and Marin-Pantelescu (2019) pointed to several obstacles that stand in front of Industry 4.0. Raj *et al.* (2019) was able to collect and summarize them to a number of obstacles as follows:

*Increase investment in industry 4.0:*

You must increase investment by 50% for the next five years in the field of digital technology and develop human resources to be ready to manage this technology (Horváth and Szabó, 2019). Inability to determine the economic benefit from applying Industry 4.0 due to doubts about its economic and production gains, and the administration's fear that technology spending may be ineffective.

*Challenges facing supply chain integration:*

Represented by the presence of obstacles between the different departments in the organization. To overcome this obstacle, there must be close cooperation between the value chain partners in addition to integration with the horizontal value chain.

*Weak integration of the internet:*

Another obstacle is the weak integration of the Internet of things in the industry environment 4.0 (Xu, David, and Kim, 2018).

*The risk of security breaches:*

Increasing communication through complicated links between partners leads to creating a state of fear of information breach or data loss and this is an important challenge for Industry 4.0 (Matt, Modrák, and Zsifkovits, 2020), especially with regard to the Internet of Things in the event of a breach.

*Low maturity of technology with priority:*

A state of chaos may occur if technologies have been introduced and have not been well tested, as these technologies may not be compatible with the environment in which they will be implemented, or they may not be within the standards related to privacy and data security, and there may not be a case of compatibility between Various devices and with an increasing number, then a state of chaos occurs, especially if the company does not succeed in the process of linking these multiple devices (Gunasekaran, Subramanian, and Ngai, 2019).

*Inequality:*

Industry 4.0 will cause social tensions in the labor market. The impact can be positive or negative, but technology will divide the market into low-skill groups with low wages, high skills, and high wages, which leads to social tension. Also, Industry 4.0 will benefit the owners of intellectual capital and their shareholders, while the gap between those who depend on work versus those who depend on capital deepens, which increases inequality.

*Disrupting existing jobs:*

Many believe that the introduction of Industry 4.0 will lead to the displacement of many human resources, which will lead to the disruption of the labor market if no alternative jobs are found for these human resources. In some regions more than 25% of jobs are at high risk of automation, some operations are expected to be simplified, others will become more complex and more integrated. This could lead to an increase in the number of highly skilled jobs and a decrease in jobs requiring fewer qualifications (Zaidin, Diah, Yee, and Sorooshian, 2018). Industry 4.0 will have a major impact on both the labor market and society, if technological changes are not accompanied by major changes in social and economic systems, social cohesion may weaken. Also, most studies agreed that the most important challenge facing the implementation of Industry 4.0 is the lack of a skilled workforce, and the need to re-train them according to changing circumstances. In the future, new ways of working are needed, which may have negative and positive effects on employees.

*Changing working conditions:*

Changing working conditions may cause problems in business organizations (Goecks, Santos, and Korzenowski, 2020). The obstacle to developing industry 4.0 is the ability of machines and computers to supervise workers, thereby depriving them of familiarity, creating dependence on robots, and people become more indifferent, more introverted, and sad, and connected to virtual life through their continued engagement with computers, programs, and machines.

*Lack of experience:*

Adding to the lack of experience is another hindrance to Industry 4.0. The lack of culture, visions or internal training in the digital field, in addition to the lack of specialists, which are obstacles to the accelerating development of the industry 4.0.

*Lack of regulations:*

Barriers to the development of Industry 4.0 are due to the lack of regulations and work procedures in developing countries, the lack of legislation in place to develop cloud computing, cybersecurity, augmented reality, and artificial intelligence in developing countries (Oliff and Liu, 2017). Industry 4.0 can lead to more inequality, especially in its ability to disrupt labor markets, layoffs of many workers in addition to threats of cyber terrorism, the inability to control human error, as well as cyber-attacks to control data in order to carry out frauds (Lee, Lee, and Kim, 2019).

#### **4. The Quality Weight for Industry 4.0 in Enterprises**

The withdrawals of products that suffer from manufacturing defects by General Motors and Toyota are prominent examples of important and sensitive issues in quality management, as the recall process cost these companies millions of dollars in losses due to poor quality. Service institutions face multiple quality challenges in providing care and creativity at prices Reasonable by service design and delivery processes. These enduring quality challenges pose questions about where we are in the quality journey and the extent to which traditional quality management practices

and methods understand changes in product development phases, cycle time stress, and staff efforts to match demand and customer expectations. In the era of Industry 4.0, it is the ideal solution to achieve all the requirements of high quality, as a high-quality environment can be created through Industry 4.0 (Müller, 2019).

Quality in Industry 4.0 contributes to ensuring competitiveness and economic sustainability. Quality is the set of advantages and characteristics of a product or service that affects its ability to meet implicit needs. Therefore, the state is required to set a plan for quality management in industry 4.0 and to adapt the industry 4.0 to the environment in which the application is intended and to know the determinants in order to address them and to get rid of all obstacles to the application of industry 4.0, that industry 4.0 enhances economic growth and profitability of the industry and improves the cost and increase the level of quality (Zaidin, Diah, Yee, and Sorooshian, 2018).

Industry 4.0 contributes to improving the quality of products and processes throughout the entire life cycle. In order to achieve a better understanding of the effects of industry 4.0, the best thing is to implement a SCOR model and devote it to the effects of industry 4.0 on quality management. Given that the (SCOR) model represents a firm model for describing activities in operations management for research and practice, quality management can be considered one of the pillars of productivity improvement (Müller, 2019). Today's manufacturing companies have to produce high-quality products in order to maintain competitiveness and meet the ever-increasing demands of customers. Hence, the primary and key condition for any company's sustainable economic success is a focus on quality management.

Through its concepts (Smart Factory, Physical Cyber System, Internet of Things, and Services), Industry 4.0 offers promising opportunities for quality management and this can be achieved in Industry 4.0 through. (Vertical, Horizontal, and Comprehensive Engineering Integration) (Foidl and Felderer, 2015). The industry 4.0 era requires new quality management systems due to the increasing complexity of the global business environment and the emergence of advanced digital technologies. New ideas can be used for predictive quality management, and it is also possible to implement predictive maintenance provided by advanced technology in various industries by taking advantage of big data analytics, Smart sensors, and artificial intelligence. These predictive quality management systems can become live ecosystems that can perform cause-and-effect analysis, big data monitoring, analytics, and effective decision-making in real time. The use of technology to improve quality is important because it facilitates changes in culture, leadership, collaboration, and compliance (Lee, Lee, and Kim, 2019).

## **5. Materials and Methods**

Analysis of many reports shows that Industry 4.0 has great potential, in particular in the area of production technology development and new opportunities to create

customer value, i.e., implementation of new business models. Smart factories allow us to meet individual customer requirements, assuming costs similar to mass production. It becomes possible to introduce flexible changes in production and provide the ability to react quickly and predictively to disturbances and failures. In addition, it is also assumed that Industry 4.0 is expected to influence the more efficient use of resources and energy (Nosalska Śledziowska Włoch Grace 2019). Industry 4.0 in Poland can be analyzed in terms of the following indicators:

- NRI (Networked Readiness Index<sup>18</sup>) developed for the needs of the World Economic Forum (Man and Man, 2019).
- DESI (Digital Economy and Society Index<sup>19</sup>) - an index summarizing about 30 indicators, developed by the European Commission to monitor the level of digitization of EU countries as well as Iceland, Norway and Turkey.
- EDPR (European Digital Progress Report<sup>20</sup>) created for the EU on the basis of DESI, also takes into account the actions of states in the field of legislation. According to the NRI index (2016), Poland ranks 42 out of 139, according to the DESI index (2018) Poland ranks 24th out of 31, and according to the EDPR indicator (2017), Poland ranks 23rd out of 28.

Position in the DESI and EDPR rankings puts Poland in a group of low-performing countries, which also includes Romania, Greece, Bulgaria, Italy, Hungary, Croatia, Cyprus, and Slovakia. Despite the improvement observed year by year, Poland still does not exceed the average for the European Union countries in any category. The categories rated relatively best in Poland are ICT infrastructure and human capital. Categories such as the use of the Internet by companies, the integration of digital technology and digital public services pose the biggest challenge.

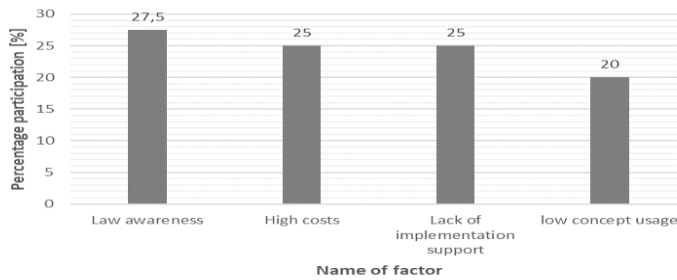
The research was conducted by means of diagnostics opinion CAWI (Computer Assisted Web Interview) questionnaire. The research was conducted among 40 respondents (owners/employees) of enterprises located in various regions of Poland. The study was dominated by men (67.5%), with higher education (87.5%), aged 40 ÷ 50 years (32.5%) with seniority 21 ÷ 25 years (25.6%). The study was conducted between February and June 2020. The research novelty is analyzing employees' awareness without a strictly technical or organizational perspective. Such disconnection reflects the level of awareness of employees in the studied area. The limitation and difficulty in the research was the low level of employees' knowledge of industry 4.0. Even the companies using these solutions did not take care of the appropriate knowledge among their employees, which complicates moving smoothly on this topic.

## **6. Results**

The research results and their analysis show that the main barrier to the implementation of industry 4.0 in the company is primarily low awareness, high costs, and lack of support in implementing the concept (Figure 1).



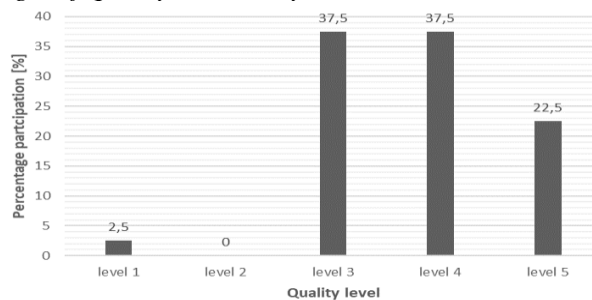
**Figure 1.** Barriers to the implementation of industry 4.0 in the enterprise



**Source:** Own study.

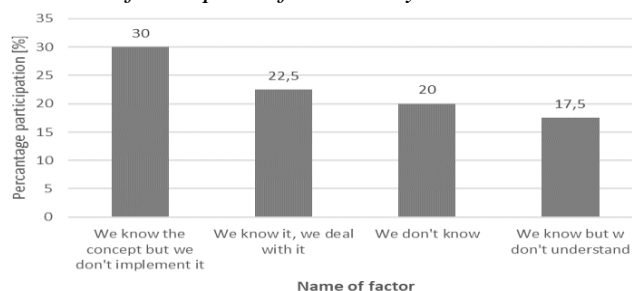
The study analyzed the area of quality in the enterprise implementing the concept of industry 4.0 (Figure 2). The research results have shown that, despite the fact that the analyzed enterprises are on the initial way of implementing the concept of industry 4.0, they already notice a significant improvement in terms of quality. In the further part of the study, the readiness of enterprises for industry 4.0 was analyzed (Figure 3). Studies have shown that 30% of enterprises know the concept but do not implement it, 22.5% of enterprises know the concept and order it, as many as 20% of enterprises do not know the concept and 17.5% of those surveyed know the concept but do not understand it.

**Figure 2.** The weight of quality in industry 4.0



**Source:** Own study.

**Figure 3.** The readiness of enterprises for industry 4.0



**Source:** Own study.

Based on the analysis of survey results, factors that directly affect employees' awareness of their involvement in industry 4.0 have been identified. Survey results are qualitative variables. Compliance test was used to investigate the relationships among these types of variables. Research on the relationship between variables in each case involves two factors. Among them, one can distinguish, for example, understanding industry 4.0 and its manifestations in the enterprise. The demonstrated convergence of features allowed for a measure of the relationship between two qualitative features. This relationship was calculated using the C-Pearson coefficient. The level of significance 0.05 was adopted in accordance with the principles of descriptive statistics, while the number of degrees of freedom ( $\alpha$ ) depends on the number of factors between which relations occur and reduced by 1 ( $\alpha - 1$ ).

**Table 1.** Relationships between factors determining employees' knowledge about enterprise security

<i>Relationship between variables</i>	<i>C-Pearson coefficient</i>	<i>Strength of dependence</i>
<i>Understanding industry 4.0 - manifestations of industry 4.0</i>	0,91	Very strong
<i>Industry challenges 4.0 - managers' tasks</i>	0,78	Very strong
<i>The importance of industry 4.0 for the enterprise - manifestations of industry 4.0</i>	0,65	Strong
<i>Industry challenges 4.0 - readiness for industry 4.0</i>	0,61	Strong

**Source:** Own study.

The analysis shows that relations between the studied elements are of varying intensity. The existence of relationships between individual variables has been confirmed using the chi-square test for each of the relationships listed. The strength of the shown dependence was examined by the C-Pearson coefficient. A strong correlation has been demonstrated between the importance of industry 4.0 for the enterprise and its manifestations in the enterprise, as well as challenges for the industry and the readiness of the enterprise to implement it, the obtained very strong relationships testify to the close connection of factors, this applies to the manifestations of industry 4.0 and its understanding and the challenges posed to industry 4.0 and tasks of managers. The obtained results of the conducted analysis verify that the existing relations and their strength seem to indicate the correctness of the undertaken research topic.

## 7. Discussion

The implementation of Industry 4.0 solutions on a large scale will introduce radical changes on the labor market. Accessibility and low employee costs will lose importance. Digitization, ubiquitous sensors and metering of production technologies as well as real-time control will enable the creation of products and services of much higher quality than today. At the same time, the demand for employees and companies specializing in areas such as the production and operation

of complex systems (integrating robotics, automation, artificial intelligence, and various devices and sensors of the Internet of Things) will increase. Education will also be key, as it will ensure a steady stream of employees able to integrate knowledge in robotics and ICT.

All these factors are, above all, an opportunity for Poland, because we do not have large international technology companies in the country that would be threatened by the current market transformation. The answers of Polish entrepreneurs to the question why they do not invest in robotics testify to the lack of knowledge about available solutions. In view of the wide spectrum of Industry 4.0 solutions, from simple robots to very complex production lines, opinions that their business is unsuitable for robotization, their production is too small, or see no measurable economic benefits, should not take place. Industry 4.0, artificial intelligence, the Internet of Things, and energy and ICT security are key areas that currently determine the role of Poland on the global economic map. Whether Poles and Polish companies will be important players on this map depends primarily on the readiness of Polish entrepreneurs to take on new challenges, their knowledge, and national support mechanisms for these specific areas.

## **8. Conclusions**

The use of industry 4.0 solutions will play the role of an institution supporting development to a significant extent economic growth of enterprises and, consequently, the development of the country. This work was specifically aimed at presenting knowledge about industry 4.0, the behavior of entrepreneurs, solutions that are foreign to them and known to them. Individual factors such as interpersonal trust, individual approach, perceived benefits / cost and individual effectiveness must influence the willingness to implement such solutions. In addition, organizational factors such as leadership support, motivation / reward, leadership, and organizational culture are also strong supporters in developing the organization. Some of these issues have already been analyzed; the rest will be described in the next publication.

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