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## The Role of Internal and External Factors in the Implementation of Industry 4.0 Principles

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**Abstract:**

**Purpose:** This study aims to identify to draw attention to the role of internal and external conditions in the process of implementing the assumptions of the IR 4.0 era.

**Approach/Methodology/Design:** Based on a structured and standardized survey questionnaire, the survey was conducted using the CATI technique from April to May 2024 among owners of micro and small enterprises operating in Poland.

**Findings:** The results indicate that, the effectiveness of enterprises in the IR 4.0 era depends on many conditions, not only technological, but also social. This is a prerequisite, as consumer needs dictate restrictive conditions for managers in the IR 4.0 era, while at the same time directing a shift in thinking towards openness, not only in terms of manufacturing and logistics approaches, but also in terms of management.

**Practical Implications:** The results of the study may serve as a guide for small and medium-sized enterprises located in Poland and the EU.

**Originality/Value:** The study identified external and internal conditions important for the development of IR 4.0 that influence implementation in the companies surveyed.

**Keywords:** Era of Industry 4.0, external conditions IR 4.0, internal conditions IR 4.0.

**JEL classification:** L1, O3.

**Paper Type:** Research paper.

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## **1. Introduction**

The modern world is undergoing constant changes that affect various spheres of life. This applies to economies, organizations, and people. Technological transformations initiated in the 18th century led to the emergence of the fourth industrial era (IR 4.0, Industry Revolution 4.0, Industry 4.0). Changes in the business environment resulting from IR 4.0 are transforming entire industries. They are creating new opportunities and challenges, forcing companies to strategically renew themselves through dynamic changes in their business models, while transforming traditional management processes, including business operations and value chains (McKinsey & Company; Arnold *et al.*, 2016).

This article suggests that in order to meet these challenges, it is necessary to understand the basic business logic. Therefore, it is crucial to explain the conditions of the IR 4.0 era that determine changes in companies. This will allow the creation of a matrix describing new relationships that are being formed in various areas of business activity and their dynamic transformations resulting from many new processes.

In such conditions, management becomes a challenge for managers accustomed to a hard analytical approach (Deloitte). However, despite the significant impact that these phenomena will have on companies in the coming years, research in this area is still rare (Lu, Cecila 2016). Most publications focus on technological aspects, not taking into account other conditions influencing business strategies.

The article presents external and internal conditions as a stimulus or determinant of the development of companies in the new era of IR 4.0. The aim of this article is to draw attention to the role of internal and external conditions in the process of implementing the assumptions of the IR 4.0 era.

Therefore, there is a research gap in this area because while much has been written about the importance of this issue in relation to the activities of large enterprises, there is still little research on micro and small enterprises. Taking steps to clarify the research gap, this study aims to assess the degree of involvement of small and medium-sized enterprises in the era of IR 4.0 and its relationship with the determinants.

The achievement of the adopted objective will allow drawing conclusions about the involvement of SME owners in the implementation of the determinants of the IR 4.0 era. The paper consists of five parts. The first part describes the theoretical foundations of the IR 4.0 era, the second systematizes the internal and external determinants of the IR 4.0 era, the third part covers the methodology, the fourth part presents the research results, and the last part is a discussion of the results and their limitations

## 2. Literature Review

Today, the world is undergoing constant change affecting various spheres of life for economies, organizations and people alike. The increase in technological, economic, social and cultural change that began in the 18th century has now led to the emergence of the fourth industrial era (Industry 4.0, 4th Revolution, Internet of Things or SMART, Industry Revolution 4.0 - IR 4.0). The authors agree that before this happened, the world had to go through three industrial revolutions in the past. At the end of the 18th century, the first industrial revolution took place, which began the so-called age of steam. Its main achievement was mechanical production assisted by water and steam power.

The beginning of the 20th century saw the second industrial revolution, which ushered in the age of electricity. During this time, mass production was widespread and production lines were established. The third revolution took place in the 1970s and was referred to as the scientific and technological revolution. This time saw the development of high-tech industries and the digitization of production processes.

Although it is difficult to point to a single day, week or month that marks the cut-off date between the ending and the new period in the history of individuals, countries or societies, today, in the second decade of the 21st century, we are witnessing the fourth industrial revolution (Schwa, 2017). The changes that occur between the stages are an evolutionary process. Slowly one reaches a state in which the new replaces the old, but the previous technological advances are often used.

New technologies have already fundamentally changed the development conditions for organizations three times, hence today we have an era: Industry 4.0, Industrie 4.0, IR 4.0 or Industry 4.0. The term Industry 4.0 (Industrie 4.0, IR 4.0) was used for the first time in 2011 at an industry fair held in Hanover. At that time, a working group of Bosch representatives presented recommendations to the German government on the new concept, through which, it was assumed, the competitive position of German companies would be strengthened.

The term Industrie 4.0, referring at the time to a “strategic initiative” of the German government, became synonymous with the vision of a new reality for global industry. The original wording of the term, as a result of its widespread internationalization, took on an English-language version - Industry 4.0.

The guidelines and considerations described in the planned strategy for the development of Germany's economy have spread more widely and today pose a challenge to companies operating throughout Europe, as well as globally.

The era of 4.0 presupposes the existence of intelligent systems that are networked, that is, they are connected to other processes taking place inside the enterprise, these in turn are connected to networks that create value in different areas of their

operation. In the new environment in which businesses operate, two realities intersect: the real (Physical Reality, PR) and the virtual (cyberspace, Virtual Reality, VR) (Adamik and Nowicki 2017).

In the process, various types of inter-organizational cooperation networks (Network Cooperation, Virtual Network), new technologies based on computerization, digitization, robotization (Cyber-Physical Systems, CPS), real-time dynamic processing of large amounts of data (Big Data Analytics, BDA), Internet of Things (IoT) connections, among others, are constantly developing.

Internet of Things, IoT; Internet of Services, IoS), close, partnering relationships between people (Cooperation, Partnering, Team Working), between organizations (Strategic Partnering, SP, Knowledge Partnering, KP; Coopetition), but also between machines (Machine to Machine Communications, M2M; Artificial Intelligence; Neural Networks) . Manufacturers that implement IR 4.0 solutions can reduce production costs and flexibly respond to customer needs, thus gaining an important competitive advantage.

The new era, which began to take on a life of its own, has emerged many interpretations, the term Industry 4.0. While the previous three industrial revolutions were defined ex-post, the fourth can be referred to ex-ante, which poses a certain terminological difficulty. For the popularization of the new breakthrough has prompted many researchers from different scientific fields and countries to try to define the term Industry IR 4.0 (Bodrow 2016; Francalanza, Borg, and Constantinescu, 2017; Gentner, 2016; Padilha and Gomes, 2016; Deloitte 2015).

In general, the concept of Industry 4.0 (Kagermann, 2015) indicates that the term, is a connector for a number of fields i.e.. engineering, information technology and management sciences. It also refers to phenomena that affect the entire economy, so considering the process only to technological activities is a major limitation.

The purpose of transformation 4.0 is to increase the competitiveness of traditional industries and adapt to the changing environment and compete with digital business. The prerequisite is to create and strengthen customer value and develop the company's ecosystem by creating breakthrough creative business models based on modern technologies, without making them the most important.

Technologies are reducing and demolishing certain barriers that have hitherto hindered the tasks of some employees (e.g., people with physical disabilities can now be employed in production). The basis of this transformation is thus the disappearance of barriers between different spheres, organizations, people and machines.

Such a combination is indicated by the works of Kagermann, Wahlster, and Johannes (2013), Koch, Kuge, Geissbauer, and Schrauf (2014), Kagermann *et al.*

(2013), Mrugalska *et al.* (2017). The authors note that the era of IR 4.0 influences not only technological transformations, but defines the role and place of humans in the new world. Therefore, the interaction taking place between humans and machines must both exist in the socio-technical system of the IR 4.0 enterprise, and respect the determinants affecting this process.

As a result of the new era, entire industries are changing most often due to the rapid pace of innovation, digital transformation of companies and their business processes (Digital Transformation, DX), the dominance of smart production and logistics processes (Smart Production, Smart Logistic), mass customization of products (Mass Customization), as well as various forms of collaboration, knowledge management and continuous learning (Porter and Heppelmann 2016).

Thus, it is noted that the 4.0 era is a time of great breakthroughs for organizations, not only technological, but also social, political or economic. As V. Terziyan, S. Gryshko and M. Golovianko - the new era gives a new shape to the vision of the functioning of companies, although it particularly refers to: manufacturing products, providing services, managing assets and conducting business (Geissbauer, Vedso, and Schraff, 2016).

This is confirmed by Pereira and Romero, who point out that Industry 4.0 represents great potential for many areas, by which its implementation will affect: streamlining production, product quality, optimizing the relationship between customers and the organization, new business opportunities and economic opportunities, and the transformation of the current enterprise environment (Pereira and Romero 2017).

The implementation of Industry 4.0 results in effects both at the level of national industries and individual enterprises, in terms of business, operational, social and environmental aspects. Thus, for example: at the enterprise level, business effects related to :

- precise, rapid identification and adaptation to market needs - by combining information from the environment, with data on the operation of the company, and flexible configuration of manufacturing systems and integration in the value network,
- higher profitability - thanks to the precise realization of individual customer expectations, identifiable online in every phase of product development,
- higher sales - thanks to the development of individual, niche products, whose share in the sales of a given range becomes dominant with a developed information exchange infrastructure,
- additional revenues - due to the creation of new business models based on the sale of functionality, rather than the product itself, through the ability to monitor its exploitation.

In turn, operational effects are:

- improvement of resource efficiency - due to the ability to flexibly and rapid adjustment of means of production to current needs, with transparency of information about the state of resources and current needs,
- improvement in product quality - thanks to the availability of data, the ability to analyze trends leading to defects and preemptive countermeasures,
- avoidance of downtime and failures - thanks to predictive maintenance (McKinsey&Company 2017).

In addition, based on ongoing research and expertise, it has been estimated that changes related to the operation of enterprises in the era of IR 4.0 can result in: increased productivity,- reduced downtime of machinery and equipment, increased labor productivity through automation, reduced inventory costs, reduced quality costs,- increased accuracy of forecasts, reduced time to market, reduced maintenance costs of machinery and equipment .

Achieving and then developing the aforementioned effects requires, first: a change in the way of thinking about conducting an open, active, dynamic and flexible business (Blanchet, 2019), and second: that the enterprise recognize and respect the many determinants triggered by the IR 4.0 era. These determinants are respected by various factors, influencing in different directions (stimulating or dissimulating) and with different strength on the intensity of the enterprise's efforts towards IR 4.0.

To a large extent, their implementation depends on the strength of the influence of external determinants arising from the environment and internal ones arising from the organization's environment (Frank and Dalenogare 2019). External factors that are a source of opportunities and possibilities, but also threats and constraints, can support or constrain the actions taken and have a direct and indirect impact on the company's environment.

Currently, publications relating to IR 4.0, in a rather general way explain the determinants of development important for enterprises operating in the new era. More often, attention is paid to technological factors characteristic of the IR 4.0 era while ignoring other important motives . If this were the case, the change in the way enterprises operate would be limited only to the implementation of certain technologies.

Technology in the era of Industry 4.0 should only play a utilitarian role, because it is of secondary importance, in view of the virtualization of resources and flexibility of the enterprise with the environment.

Respecting the new conditions is to serve better communication, and changing the way of thinking about the resources and boundaries of the organization, is at the heart of the transformation of enterprises.

In turn, A. Białobłódzki and his team, identified the most important manifestations of each group of conditions of the IR 4.0 era. Selected approaches are presented in Table 1.

**Tabel 1.** *External conditions of the IR 4.0 era*

| <b>External conditions</b> | <b>Manifestations</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|----------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Social</b>              | <ul style="list-style-type: none"> <li>• creation of new forms of inter-organizational cooperation,</li> <li>• intensified open relations with customers,</li> <li>• continuous learning and competence development,</li> <li>• teamwork,</li> <li>• increased collaboration and connections with employees and key partners,</li> <li>• new quality of open communication,</li> </ul>                                                                                                                                                                                                                                    |
| <b>Technological</b>       | <ul style="list-style-type: none"> <li>• increasing digitization of businesses,</li> <li>• integration of new technological systems with old ones,</li> <li>• the possibility of using innovative technologies,</li> <li>• innovative open technologies,</li> <li>• digitization of business processes, going beyond the enterprise to include open “anywhere, anytime” operations,</li> <li>• implementation of innovative products, processes and technologies,</li> <li>• new technical solutions involving enhancing the capabilities of employees,</li> <li>• IT and software know-how as a key resource,</li> </ul> |
| <b>Ekonomical</b>          | <ul style="list-style-type: none"> <li>• an increase in spending on innovation and R&amp;D activities,</li> <li>• creation of new open business models</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>Ekological</b>          | <ul style="list-style-type: none"> <li>• commercialization of two technologies that reduce energy consumption to quasi-zero levels based on: 1) renewable sources; 2) hydrogen,</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>Political</b>           | <ul style="list-style-type: none"> <li>• relocation and implementation of production to countries with more favorable technological solutions,</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Cultural</b>            | <ul style="list-style-type: none"> <li>• openness of entrepreneurs and employees to new technologies,</li> <li>• creation of new man-machine relations,</li> <li>• creation of values based on innovation,</li> <li>• creation of values based on knowledge sharing and cooperation,</li> <li>• creation of values based on open relations with various stakeholders and open communication,</li> <li>• creating values based on integration trust,</li> </ul>                                                                                                                                                            |
| <b>Legal</b>               | <ul style="list-style-type: none"> <li>• open communication between the main components of the Industry 4.0 network on the basis of massive amounts of data, going beyond the secure internal network,</li> <li>• procedures for commercialization of knowledge and technology.</li> </ul>                                                                                                                                                                                                                                                                                                                                |

**Source:** *Own study based on Białobłódzki et al. 2020.*

In the face of the proposed conditions, the image of the new organization of the future identified not only with technological development, but also with social, ecological, economic, etc., is being formed. Therefore, the various extrinsic organizational determinants generated by the era of IR 4.0, indicate not only the need for technological transformations, but also those occurring in the enterprise environment itself.

Thus, it can be seen that the given external conditions resulting from the changes in the modern environment will have an impact on the changes taking place in the enterprise itself. This means that the internal conditions of a given enterprise will be responsible for the success of their application. Thus, the literature raises the question - what are the main areas of enterprise operations affected by the above-mentioned determinants of the IR 4.0 era?

Researchers over the years have identified many such areas, but from the perspective of so-called “open” management, those seeking an answer to this question were able to compare with each other the signaled in the international literature (Bawany, 2017; Kesler, Kates, and Oberg, 2016; Neeley, 2015) and finally collated by A. Adamik, the key areas for the development of enterprises in IR 4.0, which include: strategies , technologies, structural solutions and attitudes and social competencies.

It was also found that the listed external conditions can affect each of the listed areas, which are internal conditions within which various adaptation processes must take place in the enterprise. Selected approaches are presented in Table 2.

**Table 2.** *Internal conditions of the IR 4.0 era*

| <b>Internal conditions of the IR 4.0 era</b>           | <b>Characteristics (determinants of change in enterprises in the era of IR 4.0)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|--------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Strategy</b><br>(Ibarraa, Ganzarain Igartuaa, 2018) | <ul style="list-style-type: none"> <li>• development of the area of openness to relations with the environment, i.e., strategic openness with multiple stakeholders,</li> <li>• professionalization of management,</li> <li>• close relations with customers,</li> <li>• openness to cooperation with other entrepreneurs in the area of advanced technologies,</li> <li>• openness to cooperation with the scientific/ R&amp;D sphere,</li> <li>• exploration of the environment for the development of the enterprise in the era of IR 4.0,</li> <li>• openness of strategy,</li> <li>• building a network of knowledge exchange links between the enterprise and the environment,</li> <li>• flexible adaptation to changes in the environment,</li> <li>• open innovation in implementation processes or significantly improved production methods or products,</li> <li>• collaborative idea generation,</li> </ul> |

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|---------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Technology</b><br>(Oztemel,<br>Gursev, 2020)               | <ul style="list-style-type: none"> <li>• development of the knowledge area - i.e., introduction of new technologies,</li> <li>• developing and acquiring new knowledge in the development of IR 4.0,</li> <li>• good relations with contractors, implementation of open innovation and generation of technical progress based on scientific research,</li> <li>• implementing innovative solutions working with selected institutions,</li> <li>• implementing innovative solutions using the results of scientific research,</li> <li>• creativity,</li> <li>• attitude to innovation,</li> <li>• implementing new technologies, products and processes and organizational solutions,</li> <li>• conducting research and development activities on their own, studying the environment in terms of the need for new knowledge,</li> <li>• aproactive market attitude expressed by taking innovative actions,</li> <li>• seizing opportunities for the future success of the company through innovations and upgraded offerings,</li> <li>• product innovations-introducing a product to the market</li> </ul> |
| <b>Structural solutions</b><br>(Davies, Coole,<br>Smith 2017) | <ul style="list-style-type: none"> <li>• development of the area of implementation of change-i.e., the company's ability to implement changes stimulated by the use of development support instruments,</li> <li>• willingness to take calculated risks,</li> <li>• active market attitude expressed by taking action in response to opportunities arising in the company's environment,</li> <li>• continuous collection of feedback from customers,</li> <li>• study of market participants (customers, suppliers, competitors, etc...),</li> <li>• alignment with the needs of key stakeholders,</li> <li>• shorter product development time,</li> <li>• technological innovation - includes new products and processes and significant technological changes in products and processes,</li> </ul>                                                                                                                                                                                                                                                                                                         |
| <b>Attitudes and competences</b><br>(Ellis 2018)              | <ul style="list-style-type: none"> <li>• developing the area of flexibility - i.e., the area in which the company is capable of meeting the expectations of the IR 4.0 era,</li> <li>• stimulating employees and management to take innovative actions,</li> <li>• open flow of information and rapid decision-making process,</li> <li>• creating activities based on open exchange of knowledge,</li> <li>• sharing knowledge,</li> <li>• listening to and implementing employees' ideas,</li> <li>• building own development facilities,</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |

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|--|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  | <ul style="list-style-type: none"><li>• providing employees with open access to the necessary knowledge, creating an open communication system,</li><li>• organizing teamwork in cooperation with employees of scientific units,</li><li>• creating among employees an attitude of openness to knowledge and new solutions,</li><li>• increasing internal efficiency in decision-making and action,</li><li>• create an open communication system.</li></ul> |
|--|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

*Source: Own work based on.*

However, a report compiled by Deloitte Global in 2020 shows a certain gap between the actual internal preparedness of companies and their readiness to implement changes dictated by the given external conditions . The result is a cognitive dissonance between the changes observed in the IR 4.0 environment and the adaptability of enterprises.

Therefore, researchers as well as practitioners point out that the two groups of determinants should be considered together, as it is important not only to evaluate them separately, but in particular the interactions occurring between them. Thus, it is important to understand that the described external determinants have both direct and indirect effects on each of the described internal determinants

### **3. Research Methodology**

Based on a structured and standardized survey questionnaire, the survey was conducted using the CATI technique from April to May 2024 among owners of micro and small enterprises operating in Poland.

The study involved small and medium-sized enterprises. The sampling frame was the REGON registry database, considered a complete sampling frame for companies operating in Poland.

The research sample consisted of 393 business entities operating in Poland, of which 73.79% were small enterprises (from 10 to 49 employees), 26.21% were medium-sized enterprises (from 50 to 249 employees), which reflects the structure of the population of enterprises in our country in selected size groups.

Taking into account individual metric data, the group of entities studied can be characterized in terms of: organizational and legal form, age, dominant sector, technological advancement, area of market activity, employment size, financial result, level of environmental variability and degree of environmental predictability.

As a result of the process of case selection for the study, a group of entities was finally created, which can be characterized in terms of the following factors:

- **period of operation** - the largest number of the companies, 67.18%, has been operating on the market for over ten years, with 22.9% of companies operating over a period of three to ten years. Therefore, they are characterized by an already confirmed phase of development. The smallest number of companies, 9.92%, have been operating in the market for zero to three years;
- **type of activity** - by type of activity, production companies were the most numerous - 44.5%, followed by trade companies - 34.35%, and service companies - 21.12%;
- **legal form** - with regard to the legal and organizational form, a large part of the surveyed businesses were sole proprietorships (50.13%). These were followed by partnerships (26.21%) and limited liability companies (22.9%);
- **innovation level** - for the businesses analyzed, this can be described as mostly high, as the vast majority of the companies, 61.58%, were active in the high-tech area, while 38.42% of the companies were active in areas considered as medium-high-tech. Additionally, innovativeness of the businesses was measured by the level of novelty of the most significant changes, in the opinion of the respondents, introduced in the years 2021-2024. The study took into account the novelties that the companies introduced to the products it offers, i.e. new improved products/services, improved methods of production/service provision, and changes in the organization of their operations. In the studied sample, most companies, 78.9%, were innovative;
- **location** - most of the surveyed businesses operate on the domestic (29.01%) and regional (28.50%) markets. Others operate on the local market (23.41%) and the international market (19.08%);
- **financial result** - as for the financial result, more than a half (54.96%) of the businesses assessed their situation in 2018 as good. A loss was reported by 22.65% of the businesses and no clear answer was given by 22.39% of the businesses.

#### 4. Research Results

The first year of analysis was respondents' assessment of their overall familiarity with the determinants of business development in the IR 4.0 era. Respondents made their assessment on a 5-point Likert scale, where 1- is no familiarity, 2- little familiarity, 3- medium familiarity, 4- great familiarity, 5- very great familiarity.

According to the survey: 18.2% of respondents were not familiar with such assumptions, 20.0% were familiar to a small extent, 47.8% showed medium familiarity, 10.0% were familiar to a large extent, and only 4.0% were familiar to a very large extent.

Respondents evaluated the actions taken by the company within the framework of the conditions of the IR 4.0 era. The characteristics of the listed conditions were used for the research.

Thus, the first research area was to identify the manifestations of individual external determinants in the activities of individual enterprises in the IR 4.0 era.

Within the framework of the development of social determinants in the IR 4.0 era, the actions taken by an enterprise to establish various relationships with stakeholders in the environment are important.

Unfortunately, the majority of enterprises indicated low importance for the development of various forms of cooperation. The following are mostly not practiced in the surveyed enterprises: contractual relations 53.9%, capital relations (47.1%), network relations (40.1%), cluster relations (64.1%). The exceptions are partnership relationships - as 30% of respondents rated their importance as medium, and transactional relationships, which for 31% are of high importance.

On the other hand, the most frequently taken actions for the development of social determinants of IR 4.0 are: open relations with customers (especially in the area of new products/services introduced (34.2% of indications), creating among employees an attitude of continuous learning and competence development (23.3% of indications). And the least frequent are: organizing teamwork in particular in cooperation with employees of scientific and research units (5.6% of indications), and building new IT systems and open communication (2.3% of indications).

This was followed by an assessment of activities carried out within the framework of technical conditions, based mainly on the introduction of new technologies in cooperation with various institutions. As the survey showed, more than 45% of companies unfortunately do not implement innovative solutions in conducting cooperation with various organizations. 12.7% of the surveyed companies implement innovative solutions by cooperating with selected institutions, such as financial - obtaining additional sources of funding and innovation and technology transfer support centers.

Only 2.5% of companies implement such solutions using occasional results of scientific research, cooperating with scientific centers and other entities supporting the financing and commercialization of technology. For 2.0% of the respondents, implementing innovation and generating technological progress based on scientific research is the most important activity of the company. For this purpose, the surveyed companies most often use, for example: cooperation with scientists, research centers, technology transfer centers, local government agencies, financial institutions and other high-tech enterprises.

The main manifestations that favor the development in the era of IR 4.0 of technical conditions in the surveyed companies according to respondents are: openness to cooperation with other companies (58%), creativity, orientation to innovation, implementation of new products, processes and technologies and organizational solutions (49%), willingness to take calculated risks (48%), preparation of a market offer tailored to the market needs of customers (36%), other characteristics that favor the development of companies in the era of IR 4.0 (31.0%), an active market attitude expressed by taking action in response to opportunities arising in the company's environment (29.0%), a focus on conducting research and development activities in-house (26.46%), stimulation of employees and management to take innovative actions manifested in mutual mobilization and a favorable work atmosphere (23.4%), an adequate flow of information in the company and a rapid decision-making process allowing high flexibility of action and appropriate market response of the company (19.3%).

The most common sources of knowledge about new technologies (innovations) available on the market of high importance to respondents were: the Internet, trade magazines, competitors and customers. On the other hand, the sources of knowledge about new technologies (innovations) available on the market of least importance to respondents are: the company's own R & D department (probably because many small companies do not have it due to the high cost), scientific and research units, direct contacts of company employees with scientific institution/researchers, universities (due to the lack of tradition of cooperation with the mentioned units).

Another group of evaluations included activities related to economic conditions affecting the development of businesses in the IR 4.0 era. Among the manifestations included in this group, respondents qualified: achieving higher productivity while reducing costs (45.5%), increased investment in innovation and R&D activities (23%). Rarely, however, do respondents focus on introducing new open business models. Such activity is pursued by only 8% of respondents, involves the involvement of a large number of stakeholders in the strategy development process and requires the use of various forms of inter-organizational and cooperative relationships, as shown earlier such activities are rare.

In the case of environmental considerations, through which environmental goals related to the use of renewable energy sources in the company's operations are met, only 7, 8% base their operations on such solutions. This is most often related to the use of photovoltaic panels to save electricity.

For business operations, this means that efficient use of energy leads to a reduction in the amount of energy needed to produce and ultimately deliver products and services to the market. Energy efficiency is one of the most important challenges facing the EU today, stemming from dependence on imported electricity, limited energy resources, and the need to curb climate change (IAE). There are a number of motivations in this area for companies to improve energy efficiency.

One of the main impetuses for change is rapidly rising prices, especially for electricity. These motivations must therefore guide the managers in charge of a given enterprise. Among the main barriers to the development of renewable energy in their business, respondents included: major neglect from the development of political conditions, i.e.: limited state support for financing such investments by entrepreneurs (83.2%), difficult legal support regulations (78.5%), administrative-procedural difficulties (45.7%), as well as problems with the operation of transmission networks (73.8%).

As indicated by the respondents, the most common manifestation of development for political conditions are opportunities related to the transfer and implementation of production to countries that use more favorable technological solutions. Such actions are used by 48.2% of the surveyed companies. Thus, managers must recognize that the implementation of the above-mentioned activities allows not only to obtain tangible financial benefits, but mainly can be a source of competitive advantage.

In the group of cultural determinants important for the development of enterprises in the era of IR 4.0, respondents assessed the manifestations related to the development of employee characteristics towards openness. According to them, important within this area are activities related to: development of creativity, competence and skills of employees (41.4%), avoidance of mistakes and prevention of their occurrence (41.7%), creation of values based on innovation, by increasing the chances of future success through innovations introduced and offer upgrades (29.2%), increase of efficiency and competitiveness through flexible adaptation to emerging changes and the requirements of different markets and different customer groups. (29.0%), improving the communication system (23.1%), increasing internal efficiency in decision-making and action (18.0%), creating a culture based on knowledge sharing and cooperation (27.3%), creating values based on open relations with various stakeholders and open communication (38.3%), creating values based on integration trust (69.2%), and creating new human-machine relationships (12.3%).

The last group included legal determinants, for which respondents ranked importance in turn. Knowledge of procedures for commercialization of knowledge and technology is the key to successful implementation of these conditions for 65.4% of respondents. Importance for activities related to open communication between the main components of the IR 4.0 network conducted on the basis of massive amounts of data, going beyond a secure internal network was seen by only 25% of respondents.

As noted in Chapter One of the study, the development of businesses in the IR 4.0 era is influenced by the listed external determinants, which may indirectly or directly affect internal determinants, among which were areas related to: strategy, technology, structural solutions, and social attitudes and competencies. Accordingly, the respondents evaluated the activities of their companies implemented within the framework of the indicated determinants.

Activities related to the development of the strategy in particular, one that is based on active, open exchange of knowledge and information, were evaluated first. It takes place during interaction and implementation of inter-organizational cooperation between enterprises and the environment with the cooperation of ICT tools. According to respondents, the main activities conducive to development for open strategies are: openness to cooperation with other enterprises (58%), creativity, orientation to innovation, implementation of new products, processes and technologies and organizational solutions (49%).

Companies' activities related to the second area of internal considerations, which is technological development, were rated second. The sources of knowledge on the subject of new technologies (innovations) available on the market of greatest importance to respondents were: the Internet, trade magazines, competitors and customers (76.4%).

On the other hand, the sources of knowledge about new technologies (innovations) available on the market of least importance to respondents are: the company's own R & D department (45.3%) (probably because many small businesses do not have one), scientific and research units, direct contacts of company employees with a scientific institution/researchers, universities (65.2%) (due to the lack of tradition of cooperation with the mentioned units).

The most common form of cooperation is in the design of new products: with customers (18%), with competitors (5%); with suppliers (8%), with strategic allies (3%), with scientific units and intermediary institutions (2%). Cooperation in the purchase of new technologies: with suppliers (17%), with competitors (10%), with customers (8%), with strategic allies (11%), with scientific units (3%), with intermediary institutions (2%).

In area three of the survey, the assessment of internal conditions included activities related to the implementation of structural solutions. Therefore, respondents evaluated the development of the area of change implementation, and within it - the company's ability to implement changes stimulated by the use of development support instruments (42.4%), the willingness to take calculated risks (47.8%), the preparation of a market offer tailored to the market needs of customers (36%), an active market attitude expressed by taking action in response to opportunities arising in the company's environment (29.0%), the continuous collection of customer feedback (82.3%), the study of market participants (i.e. customers, suppliers, competitors, etc...) (68.4%).

This was followed by alignment with the needs of key stakeholders (48.6%), shorter product development time (45.3%), implementation of technological innovations (37.3%), which include new products and processes, and significant technological changes in products and processes.

The fourth section in the group of internal determinants was the opinion on attitudes and competencies. To this end, respondents assessed - are there activities in their enterprises within the framework of the development of the area of flexibility - i.e. the area to what extent the company is capable of meeting the expectations of the IR 4.0 era? 18.2% of respondents said that, within the framework of these activities in their companies are used: stimulating employees and management to take innovative actions. Betting on open information flow and rapid decision-making was found in 45.2% of enterprises.

Creating behavior based on open exchange of knowledge, sharing knowledge, listening to and implementing employees' ideas are activities used in 67.5% of enterprises. This was followed by: building in-house development facilities (51.6%), providing employees with open access to necessary knowledge and creating an open communication system, creating an attitude of openness to knowledge and new solutions among employees, increasing internal efficiency in decision-making and action (24.5%). For the most part, respondents only expressed a desire to try to organize teamwork in cooperation with employees of scientific units.

Summarizing the research, it can be concluded that most companies, although recognizing the determinants of the IR 4.0 era, were largely not at a satisfactory level. This situation may be the reason for the existing barriers to the development of the IR 4.0 era in relation to the changes being introduced. This is because the barriers indicated in the survey confirm the low readiness of companies to introduce the assumptions of the new era.

Such a conclusion coincides with Roland Berger's report entitled "INDUSTRY 4.0: The new industrial revolution. How Europe will succeed", where the RB Industry 4.0 Readiness Index, was presented, and it was found that Poland was in the group of so-called 'hesitant' and traditionalist countries, i.e. those with a relatively low readiness to implement IR 4.0. As a result, it can be concluded that it should now be crucial for the surveyed companies to properly plan for the changes brought about by the IR 4.0 era.

## **5. Conclusions**

In conclusion, the effectiveness of enterprises in the IR 4.0 era depends on many conditions, not only technological, but also social. This is a prerequisite, as consumer needs dictate restrictive conditions for managers in the IR 4.0 era, while at the same time directing a shift in thinking towards openness, not only in terms of manufacturing and logistics approaches, but also in terms of management.

The literature studies conducted, the results of the research conducted and the statistical analysis made it possible to: recognize the general conditions and premises, as well as to identify activities, processes relevant to the development of enterprises (small and medium-sized) operating in the era of IR 4.0.

The analysis of the results obtained allowed us to formulate conclusions such as:

- the conditions of the IR 4.0 era, including social, technological, economic, ecological, political, cultural, and legal conditions, have created a need to build open relationships with the environment,
- the dynamics of the development of small and medium-sized enterprises in Poland in line with the conditions of the IR 4.0 era is still low, which is confirmed by the traditional approach to management in the sector under study,
- the surveyed companies operating in Poland, although increasingly aware of the benefits of IR 4.0 applications, are still not very active in the process of adapting to new requirements,
- once the conditions of the IR 4.0 era have been recognized, industrial modernization of small and medium-sized enterprises will take place through the development of inter-organizational cooperation networks, industry breakthroughs, an increase in the pace of innovation, and the recognition of the growing and changing needs of customers and other stakeholders. It should also be emphasized that the external and internal conditions mentioned above require close integration.

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