The Influence of Industry 4.0 Technology on the Organizational Culture of Companies

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Abstract

Purpose: The purpose of the article is to identify and assess the impact of key technologies of the Industry 4.0 era on the organizational culture of companies.

Design/methodology/approach: The influence of the main Industry 4.0 era technologies on characteristic organizational culture traits and key values respected in companies was explored on the basis of research-related literature supplemented by empirical studies. The studies examined the influence of selected technologies characteristic of the Industry 4.0 era.

Findings: The results served as a foundation for identifying models that characterize the influence of Industry 4.0 technologies on the organizational culture of small, medium, and big enterprises. The acquired results allow for concluding that Industry 4.0 technologies are significant and actual stimulators for the development of organizational culture in companies.

Research limitations/implications: The limitations include a relatively small research sample that resulted from the lack of consent from companies to conduct quantitative studies.

Originality/value: The presented results can play a significant role in building the Industry 4.0 era environment and serve as inspiring guidelines for management staff in terms of effective operation of their companies.

Keywords: organizational culture, Industry 4.0, technology, competitiveness of companies, fourth industrial revolution.

JEL: O14, L20

Wpływ technologii Industry 4.0 na kulturę organizacyjną przedsiębiorstw

Streszczenie

Cel: identyfikacja i ocena wpływu kluczowych technologii ery Industry 4.0 na kulturę organizacyjną przedsiębiorstw.

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Metodologia: na podstawie badań literaturowych, uzupełnionych badaniami empirycznymi prześledzono wpływ głównych technologii ery Industry 4.0 na cechy charakterystyczne kultury organizacyjnej oraz wartości cenione w organizacjach. Badano wpływ wybranych, charakterystycznych dla ery Industry 4.0 technologii.

Wyniki: zidentyfikowano modele charakteryzujące wpływ technologii Industry 4.0 na kulturę organizacyjną małych, średnich i dużych przedsiębiorstw. Zebrane wyniki pozwoliły stwierdzić, że technologie Industry 4.0 są istotnymi, realnymi stymulatorami rozwoju kultury organizacyjnej przedsiębiorstw.

Ograniczenia/implikacje badawcze: do ograniczeń badawczych zalicza się stosunkowa mała próba badaw-cza, która wynikała z braku zgody przedsiębiorstw do przeprowadzania badań ilościowych. Ograniczeniem jest również brak podobnych badań i opisanych relacji w literaturze przedmiotu co utrudniało prowadzenie analiz.

Oryginalność/wartość: zaprezentowane wyniki mogą odgrywać znaczącą rolę w budowaniu środowiska ery Industry 4.0 oraz stanowić inspirujące wytyczne dla kadry kierowniczej w zakresie efektywnego funkcjonowania przedsiębiorstw.

Słowa kluczowe: kultura organizacyjna, Industry 4.0, technologie, konkurencyjność przedsiębiorstw, czwarta rewolucja przemysłowa.

1. Introduction

We live in a time of dynamic changes and technological breakthroughs that affect many areas of our life. This is particularly visible in the economy, in which the main stress is put on the development of information and knowledge that are key components of the so-called Fourth Industrial Revolution also known as Industry 4.0. The Industry 4.0 era is focused on seeking to implement a mass product and service customization through specific techniques. This is related to the optimization of production processes, as well as efficient use of existing resources, in which people, machinery, devices, and products will communicate with each other (Guban & Kovacs, 2017). Industry 4.0 is focused mainly on technology and the implementation of specific technologies, first and foremost from the scope of automation, robotization, digitization, or even artificial intelligence (Schumacher, Erol, & Sihn, 2016). The impact of the Industry 4.0 technology is so big that it influences the majority of aspects related to the operation of companies. In particular, the Industry 4.0 technology affects the cultural dimension of companies as it creates an environment different from those the companies have known so far. It is an environment based on technology and employees, in which the symbiosis of these two elements is unavoidable (Müller, Buliga, & Voigt, 2018). Therefore, it can be assumed that a skilful creation of human behavior in organizational culture, which becomes the element that finally decides about the implementation of the Industry 4.0 concept and building a stable competitive advantage, is the key to achieve a company's goals.

Currently, the source literature lacks studies on the impact of specific Industry 4.0 era technologies on the organizational culture of companies. The

majority of studies discuss the technical aspects of the Industry 4.0 era, but do not focus on the observation of their influence on organizational culture, which is the main factor influencing the successful goals achievement. For that reason, the purpose of this elaboration will be to initiate a discussion on the influence of technologies characteristic for the Industry 4.0 era on the organizational culture of companies. Based on the review of subject literature and results of survey research among production companies, an attempt to identify the traits of organizational culture, which are influenced by specific Industry 4.0 era technologies, was made. The undertaken studies have made it possible to map the influence of technology on the organizational culture of companies.

2. Key Industry 4.0 Technologies and Their Influence on Companies

The new economic era identified as the Industry 4.0 era, also known as the Fourth Industrial Revolution era, is based on the achievements of digitization and industrialization. Similarly to the previous industrial revolutions, its main subject is the transformation of production system. The Fourth Industrial Revolution has started the implementation of great amount of data into the production environment. The environment itself is constantly transformed by mutual exchange and merging of digital technologies that create strong technological interrelations (Helbig, Kagermann, & Wahlster, 2013). The Fourth Industrial Revolution creates a reality, in which both virtual and physical systems co-operate with each other in a flexible manner and thus create products adapted to individual needs of a customer. However, it does not only apply to intelligent machines and systems. The concept itself is much, much broader. The fusion of advanced technologies and results of their mutual penetration in physical, digital, and biological fields make the aforementioned revolution significantly different from the previous revolutions. This is mainly due to the ground-breaking innovations that spread much faster and more widely in the environment, especially digital technologies (Schwab, 2013).

Personalized demands of customers force the Industry 4.0 era companies to adjust to new and shifting needs, which in turn raises the necessity to ensure a dynamic production line that manufactures not only products, but also combinations of products and services in order to meet the constantly shifting environmental conditions. To achieve this goal, the degree of production automation should evolve towards the processing of data and downloading them from the environment in such a way that allows to foresee subsequent production stages in real time with limited or no interaction with the user. At this point, we deal with artificial intelligence. In such configuration, the developed, more flexible production diagrams generate

a great amount of data at each industrial process stage. In order to analyze the data, a company needs to use an advanced, digitized network that monitors and processes such information. Such combination of Internet and "intelligent" technologies allows to interpret data in real time, which in turn enables to foresee and implement preventive measures and adjust production before a potential inconsistency occurs (De la Fuente et al., 2016).

The basic Industry 4.0 aspect refers to the ability to use cyber-physical systems, which ensure an intelligent communication between them in terms of technical issues. Such configuration is called "intelligent systems", which can be understood as a consequential result of mechatronic and adaptronic systems (Anderi, 2014). Industry 4.0 is also a search for fully integrated solutions dedicated to the operation of digital production systems (Klotz, Newman, Zhongm, & Xu, 2017). It covers a wide range of interdisciplinary technologies and concepts that allow digitization, automation, and integration of production process at various stages.

It should be highlighted that among researchers there is no clear consensus on key Industry 4.0 technologies (Ambad, Bhosle, & Vaidya, 2018; Erboz, 2017; Bonaccorsi, Chiarello, Fantoni, & Trivelli, 2018; Araujo, Barros, Mehrsai, & Santos, 2017). The number of Industry 4.0 technologies differs depending on the researcher's point of view and approach to the whole concept. However, it should be remembered that since Industry 4.0 relies on the use of production technologies that are based on computer and automation technologies also encompassing network communication technology, thereby transforming production into digital production, the source literature contains many classification methods. One of these methods is presented in the table below (see Table 1):

Table 1
Main Industry 4.0 technologies

Cyber-Physical Systems (CPS)	Internet of Things (IoT)	Internet of Services	Cloud Computing	Big Data Analysis
Allow to manage connected systems in order to interact with the physical and virtual environment. The systems integrate and co-ordinate processes and operations while simultaneously controlling them and sharing data for frequent assessment.	Concerns connection between physical objects and the Internet and gives them a form of intelligence.	New concept that gives business and technical foundations for business network between services of supplier and customer. It influences the creation of values in a chain of values.	Facilitates exchange and division of data between subsystems, installations, and systems. It renders an easy access to shared computational resources.	Allows to process a wide, complex, and big amount of data from various sources and formats in order to make better decisions. Processes, product, and customer information might be the source of data.

Source: Abouabdellah, El Hamdi, & Oudani, 2019.

The technologies listed above can constitute a base for the Industry 4.0 era, but do not reflect all possible technologies, which are currently used by companies. A much more detailed classification is shown in Table 2, which contains on overview of modern Industry 4.0 technologies. Depending on their use, the technologies can belong to Smart Factory[1] or have a digitizing and virtual nature. Technologies belonging to Smart Factory are based on cyber-physical systems, integrated with the use of industrial Internet of Things and new production organization methods. This allows a high level of customization of products and the implementation of production processes with little participation on the part of employees (Mychlewicz & Piątek, 2017). The remaining technologies are focused on virtual and strongly digitized systems.

Table 2
Detailed division of the Industry 4.0 era technologies

	INDUSTRY 4.0 TECHNOLOGIES			
SMART FACTORY	**Internet of Things (IoT)** – communication with network devices and elements; – implementation of technological solutions based on Internet network	**Data analysis and production optimization** – using data analysis and processing software that ensures access to current management information	**IT/CPS integration** – using cyber-physical systems that combine mechatronic and electronic systems; – integrating IT production and management systems	**Cybersecurity** – using measures securing against cybernetic threats inside and outside of the organization; – using strategy with industrial systems design methodology
VIRTUALISATION AND DIGITISATION	**Artificial Intelligence** – using technologies and systems that enable machinery and devices to learn and simultaneously solve problems	**3D printing** – using technology that allows to manufacture complex parts as prototypes for low volume production	**Production digitization** – using technologies that allow to manage a product's life cycle	**Cloud computing** – using structures to store and process data
	Big Data – analysis of various data sets using Artificial Intelligence algorithms; – used in production to optimize it and interpret data	**Virtual Reality** – using virtual devices, including training sessions, to support engineering staff during design works	**Co-operating robots** – using robots which possess a flexible software to co-operate with a man	**Mobile robots** – using autonomous vehicles/robots in the industry that replace traditional carriers; – flexible software
	RFID – technology that uses radio waves to transfer data and reads information on carried out production and available machinery or components	**Mobile Interfaces** – mobile devices that connect via the Internet and dispose data in real time	**Blockchain** – technology that allows to store data about transactions, a transaction platform in dispersed network infrastructure	**Geolocation** – in logistics, using a location determined by the use of a GPS module

Source: Own elaboration.

It can be clearly observed that Industry 4.0 is based on IT technologies, which allow to control operations and aggregate data. The advanced IT technologies require an appropriate infrastructure to collect and process data in production systems. Companies willing to use such technologies must have a hardware infrastructure, as well as IT systems and information sharing skills. The owned devices are becoming more flexible and, consequently, adapt to the constantly changing situation and the ever-new requirements of the 4.0 era (Chonsawat, Ramingwong, & Sopadang, 2020). However, the Industry 4.0 era should not be identified solely by technologies. The scope of the Industry 4.0 era's influence also covers applications, processes, and business models (Baaij & Schlund, 2018). The above-mentioned technologies have their consequences for and interactions with various planes and fields of organization. One of them is organizational culture. This statement gave rise to the first of the key research hypotheses:

- Main hypothesis: technologies of the Industry 4.0 era influence the shape of organizational culture of the companies that use them.
- Hypothesis 1 (specific): individual technologies of the Industry 4.0 era differently affect the features of organizational culture of the companies that use them.
- Hypothesis 2 (specific): individual technologies of the Industry 4.0 era have a different impact on the cultural values of the companies that use them.

3. Technologies and Organizational Culture of the Industry 4.0 Era

Nowadays, organizations must possess a greater flexibility and efficiency due to the fact that the global business environment has a highly unpredictable nature. Also, they need to meet the challenges that come from the growth of both national and international competitiveness. This means that there is a great need to constantly develop innovative products and, more importantly, internal processes and employee behavior (Bhanugopan, Farrell, Shanker, & van der Heijden, 2017). It should be emphasized that the Industry 4.0 era is not only information technology, systems or tools, but also, and perhaps above all, the era of smart people with well-developed knowledge, skills, competences and a modern value system, which develops their willingness to use modern technology. With their behavior and attitudes, they create a specific organizational culture of enterprises of the Industry 4.0 era.

This way, the solutions of the Industry 4.0 era in economic practice affect not only the technological level of organizational culture of enterprises, but also numerous organizational solutions based on it, e.g. work systems or qualifications required by employees.

This indicated mutual man-machine interaction must occur in the socio-technical system of the Industry 4.0 era companies (Dombrowski

& Wagner, 2017). For that reason, skipping the role of organizational culture in managing companies and its marginalization in the use of the Industry 4.0 concept, appears to be a great threat for the efficiency of implementing Industry 4.0 era solutions. According to the opinions of many entrepreneurs, organizational culture turns out to be a significant challenge in the implementation of the Industry 4.0 era requirements as it is essential and is straight up a foundation to implement quick changes that help employees to acquire and assimilate new competences and get hand of new roles resulting from new technological conditions (PWC, 2017).

From the point of view of cultural aspects, we should differentiate elements, which seem to be essential for a market success in the Industry 4.0 era. Those include, among other things: substantive knowledge, ability to learn, ability to work in a team, ability to work in a multicultural environment, ability to telework, IT knowledge, ability to share knowledge, willingness to constantly develop, focus on goals, being open to new experiences, creativity, flexible thinking, high tolerance of uncertainty, and social responsibility (Adamik, 2018; Adamik, 2020).

Although it would seem that the Industry 4.0 era requirements are dominated by technological factors, human capital is its real foundation, and becomes a vital connection between applied technologies and reality. Companies base their present and future existence on people, who create the organization's specificity and make it stand out from its competitors. Human resources create a strategic capital for companies regardless of their type of business activity, structure, or size. This capital is a component of qualifications, knowledge, skills, experience, personality, and value. As the most significant part of the intellectual asset, human resources along with structural capital are the source of competitive advantage and value of each organization in the modern knowledge-based economy. It is the most important asset of companies, however, due to its unpredictability and variability, it is difficult to manage (Moczydłowska, 2012). In order to face such challenges brought by the Industry 4.0 era and its technologies, it is necessary to create a dynamic organizational culture, which encourages creative work, inspires to try risky behaviors, and allows to take up new challenges. Such culture is known as the innovative culture (Wallach, 1983). It is characterized by great organizational flexibility and ability to create and implement new solutions in various fields. It assumes acceptance of risk and openness to any information from the environment. This culture also treats the performed work as a chance to develop and improve competences, communicates the principles of dialogue, and is focused on employee co-operation (Czerska & Rutka, 2014). Therefore, this culture minimizes employees' resistance against change, which in combination with the use of highly advanced Industry 4.0 technologies becomes a foundation to build and maintain it. Hence, it is necessary to learn about the impact of the Industry 4.0 technologies on the characteristic traits of organizational culture of companies that declare their use in their activity.

4. Methodology and Research Results

The literature review served as the basis for the identification of the research gap and research problem and was also used to define the goals that were subjected to empirical research.

Due to the fact that the aim of the work is to identify and assess the impact of key technologies of the Industry 4.0 era on organizational culture of enterprises, empirical studies were conducted on a group of 164 production companies operating within the borders of Poland. Conducted research allowed the verification of the research issues. The survey methodology was used in the adopted research objectives.[2] A structured survey questionnaire, elaborated on the basis of theoretical studies of subject literature, served as a research tool used in this part of studies. The questionnaire used for studies consisted of 4 parts. The first part concerned the type and reason for generating innovations by companies. Second part of the questionnaire covered the identification of organizational culture components. The next part of the survey questionnaire was dedicated to the knowledge and implementation of the Industry 4.0 concept in the studied companies. This part also focused on learning about the motivations of companies in applying the Industry 4.0 concept and detailing information about the technologies used, as well as the accompanying cultural elements. The last part of the survey consisted of a fiche, which allowed to characterize the surveyed companies in terms of their size, industry, scope of activity or the applicable organizational and legal form.

The studies were addressed to the senior and junior management staff of production companies on the territory of Poland, which were companies that: implemented at least one innovation (product, process or marketing innovation) within the examined period from 2017 to 2020; implemented at least one technical or non-technical (organizational or marketing) innovation in the examined period; run an innovative activity not concluded with implementation of innovation before the end of examined period. All of the examined companies have possessed valid support decisions under the Polish Investment Zone (*Polska Strefa Inwestycji*) or zone permissions under Special Economic Zones. The companies were selected on the basis of criteria covering the type of activity and declared innovation. This way, 1600 companies were selected in a purposeful way and 164 among them provided answers.

The entities covered by the study belonged to the group of large, medium and small companies. The vast majority of the surveyed entities were medium-sized enterprises with less than 250 employees, with a net sales turnover of less than EUR 50 million per year. A group of micro-enterprises was excluded from the study, due to their small share in the database and the fact that the entry criteria for obtaining state aid were not uniform over the years, and thus, would not constitute authoritative examples in

the scope of the research subject. An important piece of information in the course of the research was the differentiation of companies according to the origin of their capital and industries. The surveyed companies belonged to the following industries: plastics processing, agri-food, printing, automotive, metalworking, woodworking, furniture production, construction, clothing, electronics, civil and maritime engineering, pharmacy, energy production, cosmetics, metal production for mining.

The research results described below are a part of author's broader studies on the determinants of organizational culture of the Industry 4.0 era innovative companies. The described part focuses solely on the role of technology in the processes of shaping their culture. In total, the studies examined the influence of 14 selected technologies characteristic for the Industry 4.0 era.

The conducted studies (Table 3) show that the use of specific Industry 4.0 technologies varies depending on the company's size. In their operations, production companies often use integration with IT systems, IT network/ data analysis, wireless communication, business process automation, communication between machines, robotics and product computer simulations. Additionally, in large companies, mobile technologies and cybersecurity have been distinguished. On the other hand, small and medium-sized companies rarely use these technologies. The number of companies that declare using Industry 4.0 technologies is the greatest in the big companies' group, which might be related to the high cost of implementing such solutions, as well as profitability of using them in large-scale production. This is in stark contrast to small companies, where almost a half does not use any of the mentioned technologies. The least frequently used technologies in all kinds of companies include RFID technology, Big Data, Internet of Things and 3D printing. This might be related to relatively low popularity of these technologies in companies as they require advanced production methods, or to the fact that companies lack the knowledge on possible applications. When focusing on the most frequently selected Industry 4.0 technologies, it can be noticed that they are used in order to provide data and information in real time and to partially eliminate human labor by using process automation and robotics.

Deepening the analysis of six different Industry 4.0 technologies most often used by companies resulted in observation of their various influence on organizational culture traits depending on the company's size. Provided answers belong to the positive category, in which respondents gave "I agree" and "I definitely agree" answers.

In the case of small companies (Table 4) we deal with technologies, which influence the employees' attitude to achieving company results. They also contribute to the promotion of attitude based on openness to novelty solutions and setting on the performance of tasks and deadlines. These technologies also impact the approach to employee creativity and contribute to the shaping of both internal and external co-operation. These

Table 3

The use of Industry 4.0 era technologies in examined companies

Industry 4.0 technologies	Companies (n = 164)			
	small (n = 33)	medium (n = 77)	big (n = 54)	Sum
IT systems integration	14	24	52	90
IT network/data analysis	14	18	42	74
wireless communication/network creation	14	22	38	74
business process automation	9	21	42	72
communication between machines	12	19	41	72
robotics	17	18	35	70
computer product simulations	12	20	35	67
mobile technologies	5	16	42	63
cybersecurity	9	11	39	59
cloud computing	3	13	29	45
3D printing	7	10	27	44
Internet of Things	2	9	20	31
Big Data	1	10	18	29
using RFID technology	2	4	22	28
none	12	7	9	28

Source: Own study based on research.

Table 4

The influence of Industry 4.0 technology on traits of the organizational culture in small companies (N = 164)

Technology of Industry 4.0	Organizational culture traits						
	focus on company results	focus on co-operation and internal and external dialogue	focus on performance of tasks and deadlines	openness to novelty solutions	tolerance for mistakes	tendency to take risk	focus on creativity
robotics	15	12	13	14	8	10	12
IT integration systems	13	11	10	10	7	8	10
IT network/data analysis	13	12	11	12	7	7	11
wireless communication/network creation	13	11	12	12	7	8	12
communication between machines	12	11	11	11	5	10	10
computer product simulations	11	9	11	11	7	7	10

Source: Own study based on research.

technologies are least related to tolerance of mistakes and risk propensity. Small companies that use Industry 4.0 technologies influence these traits of organizational culture, which are related to creativity at work and performance of organization goals or tasks.

The distribution of responses in the case of medium-sized companies (Table 5) was similar to that of small companies, although, interestingly, other technologies (e.g. IT systems integration / business process automation) had by far the greatest impact on the company's performance and the achievement of tasks and deadlines. This group did not indicate robotics but did indicate the automation of business processes. Similarly to small companies, the Industry 4.0 technologies also influenced the openness to innovative solutions and creativity, as well as co-operation and creation of internal and external dialogue. The lowest impact observed includes characteristics such as risk-aversion and error tolerance. Therefore, as in the case of small companies, the Industry 4.0 technologies contribute to the achievement of planned goals and performance.

Table 5

The influence of Industry 4.0 technology on traits of the organizational culture in medium companies (N = 164)

Technology of Industry 4.0	Organizational culture traits						
	focus on company results	focus on co-operation and internal and external dialogue	focus on performance of tasks and deadlines	openness to novelty solutions	tolerance for mistakes	tendency to take risk	focus on creativity
IT integration systems	48	19	23	19	13	12	15
wireless communication/network creation	35	20	22	20	15	15	16
business process automation	37	16	19	16	9	14	15
computer product simulations	32	17	19	16	10	15	17
communication between machines	36	16	18	16	12	12	14
IT network/data analysis	26	15	18	15	10	13	13

Source: Own study based on research.

The results for the assessment of technologies used by large companies are slightly different (Table 6). New technologies such as mobile technologies and cybersecurity appear, but there is no simulation of computer products. The results for this group of companies clearly show that the Industry 4.0 technologies mainly influence the approach to performance of tasks and

deadlines and company results, while openness to novelty solutions and focus on creativity are influenced in a similar way. The least influenced factors are tendency to take risks and tolerance of mistakes. The biggest number of answers points to the big companies using IT systems integration, which influences specific organizational culture traits.

Table 6
The influence of Industry 4.0 technology on traits of the organizational culture in big companies (N = 164).

Technology of Industry 4.0	Organizational culture traits						
	focus on company results	focus on co-operation and internal and external dialogue	focus on performance of tasks and deadlines	openness to novelty solutions	tolerance for mistakes	tendency to take risk	focus on creativity
IT integration systems	48	48	49	47	33	40	47
IT network/data analysis	26	38	42	38	30	32	39
business process automation	37	37	39	38	25	30	37
mobile technologies	38	37	38	39	26	30	36
communication between machines	36	35	37	37	24	31	36
cybersecurity	34	35	36	35	21	25	33

Source: Own study based on research.

The results of all surveyed companies (Table 7) clearly indicate that the integration of IT systems has the greatest impact on the features of organizational culture, as it significantly influences the implementation of tasks and deadlines, the company's results, focus on co-operation and internal and external dialogue. Openness to novelty solutions and focus on creativity take second place in influences. The smallest influence of the Industry 4.0 technologies was observed for tolerance of mistakes and tendency to take risk.

Results systematized in such a way can enable entrepreneurs to shape specific traits of organizational culture in a more conscious manner on the basis of implementing specific Industry 4.0 technologies, which can significantly facilitate the subsequent construction of organizational culture necessary to achieve a market success in the Industry 4.0 era.

Additionally, the influence of the Industry 4.0 technologies on the values that are respected and distinguished in the examined organizations have also been studied.

Table 7

The influence of Industry 4.0 technology on traits of the organizational culture in the examined companies (N = 164)

Technology of Industry 4.0	Organizational culture traits						
	focus on company results	focus on co-operation and internal and external dialogue	focus on performance of tasks and deadlines	openness to novelty solutions	tolerance for mistakes	tendency to take risk	focus on creativity
IT network/data analysis	57	65	71	65	47	52	63
wireless communication/network creation	69	67	69	66	46	51	61
robotics	65	59	63	59	43	49	55
business process automation	65	61	65	61	38	48	59
IT integration systems	83	78	82	76	53	60	72
communication between machines	66	62	66	64	41	53	60

Source: Own study based on research.

The Industry 4.0 technologies in small companies (Table 8) most frequently impact the ability to build good relationships and tendency to co-operate. These values become combined and create an environment open to new solutions, where the ambition of employees is essential. In turn, this value is related to the improvement of competences and personal development. It is worth noting that ambition requires assertiveness and the ability to take up challenges. Competitiveness is a value that the technologies have little influence on.

Table 8

The impact of Industry 4.0 technology on the values respected in the surveyed small companies (N = 164)

Technology of Industry 4.0	Values respected in companies							
	competitiveness	assertiveness	ambition	tendency to co-operate	ability to build good relationships	improvement of competences	personal development	ability to take up challenges
IT network/data analysis	0	7	11	12	13	9	10	8
wireless communication/network creation	0	8	10	13	13	10	9	9
robotics	2	8	13	13	14	10	11	9
IT integration systems	1	6	12	11	13	9	10	9
computer product simulations	1	5	9	11	11	10	8	7
communication between machines	2	9	10	11	12	11	11	11

Source: Own study based on research.

The pattern of answers shows that the Industry 4.0 technologies most often used in small companies have a similar impact on the described values. Therefore, there is no technology typical for Industry 4.0 that has a clear impact on the values respected in the organization.

In the case of medium-sized companies (Table 9), a shift in the impact of the Industry 4.0 technologies towards the ability to take up challenges and willingness to co-operate can be observed. A similar number of responses was obtained for the ability to build good relationships and the ambition section. Ambition is also related to the improvement of competences and personal development. Both competitiveness and assertiveness have acquired a similar, small number of answers, which might suggest that those values are not highly respected in the organizations and that the applied technologies do not have a big impact on them. In this group, IT integration systems and wireless communication/network creation have the strongest influence on values developed in a company, while robotics has the smallest impact.

Table 9
The impact of Industry 4.0 technology on the values respected in the surveyed medium-sized companies (N = 164)

Technology of Industry 4.0	Values respected in companies							
	competitiveness	assertiveness	ambition	tendency to co-operate	ability to build good relationships	improvement of competences	personal development	ability to take up challenges
IT network/data analysis	3	7	16	14	15	12	11	14
wireless communication/network creation	2	8	18	16	17	16	14	18
robotics	4	5	13	13	14	9	12	14
business process automation	5	8	15	18	16	14	14	17
IT integration systems	5	9	18	20	17	14	12	19
communication between machines	3	6	15	14	13	13	11	18

Source: Own study based on research.

The greatest use of Industry 4.0 technologies was observed in the case of big companies (Table 10). However, this distribution was relatively even. Similarly to other company groups, the Industry 4.0 technologies had the least impact on competitiveness, assertiveness, and ambition. The impact on remaining values, however, was quite uniform. Responses differentiate IT integration, IT network/data analysis, and communication between machines. These technologies had the strongest influence on specific values respected in companies.

Table 10

The influence of Industry 4.0 technology on values respected in examined big companies (N = 164)

Technology of Industry 4.0	Values respected in companies							
	competitiveness	assertiveness	ambition	tendency to co-operate	ability to build good relationships	improvement of competences	personal development	ability to take up challenges
IT network/data analysis	7	21	28	38	38	37	38	38
cybersecurity	5	18	25	34	32	33	33	34
business process automation	6	20	26	38	34	35	36	37
IT integration systems	9	24	35	44	45	43	45	46
mobile technologies	7	23	31	37	33	34	34	36
communication between machines	7	22	27	35	36	32	35	36

Source: Own study based on research.

Table 11

The impact of Industry 4.0 technology on the values respected in the surveyed companies (N = 164)

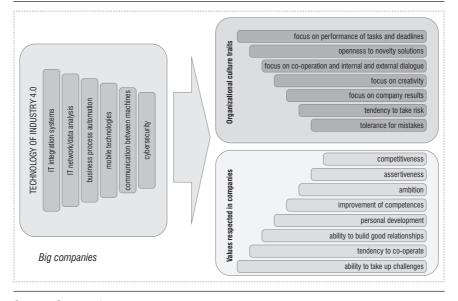| Technology of Industry 4.0	Values respected in companies							
	competitiveness	assertiveness	ambition	tendency to co-operate	ability to build good relationships	improvement of competences	personal development	ability to take up challenges
IT network/data analysis	10	35	55	64	66	58	59	60
wireless communication/network creation	7	35	55	63	61	60	56	60
robotics	16	35	50	57	56	49	53	54
business process automation	11	32	49	63	58	54	58	59
IT integration systems	15	39	65	75	75	66	67	74
communication between machines	12	37	52	60	61	56	57	65

Source: Own study based on research.

The results collected from all company groups (Table 11) indicate that the IT systems integration and IT network/data analysis have a significant influence on the shaping of values in organizations. These two Industry 4.0 technologies have a significant impact on tendency to co-operate, ability to build good relationships, and ability to take up challenges. The remaining

technologies show influence on specific values to a similar degree. The results also confirm that competitiveness and assertiveness show the weakest relationship with the technologies.

Using the research results presented above, it is possible to graphically present the influence of specific Industry 4.0 technologies on both organizational culture traits and values respected in companies. The technologies, as well as characteristics of organizational culture, were ordered in a hierarchic order as a result of current analyses. In big companies (Figure 1), IT integration systems has the greatest influence on organizational culture traits and values respected in companies. It can be clearly seen that the approach to performance of tasks and deadlines and the ability to take up challenges dominate these variables, which are strongly influenced by the Industry 4.0 technology.

Figure 1
Graphic model of impact of Industry 4.0 technologies on the organizational culture of big companies.
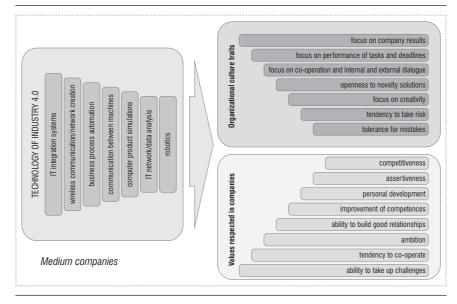

Source: Own study.

As in large companies, the integration of IT systems dominates in medium-sized companies (Figure 2), with robotics having the least impact on it. Technologies that stand out in medium-sized companies most often influence the focus on the company's results and the ability to take up challenges.

Figure 2

Graphic model of impact of Industry 4.0 technologies on the organizational culture of medium companies
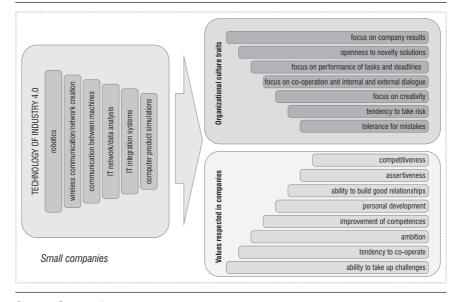

Source: Own elaboration.

Small businesses (Figure 3) have a different distribution of impacts. The tendencies related to the use of adopted technologies are clearly different, because robotics is the most common one, and computer simulations of products are used less frequently. As in the case of other company groups, the specificity of Industry 4.0 for this group of companies has the strongest impact on the focus on the company's results and the ability to take up challenges.

The results above allow to verify the assumed research hypotheses positively. Technologies of the Industry4.0 era, depending on their type and the size of enterprises, affect the values and features of the organizational culture of enterprises in different ways.

Despite the particular study results shown above, it is necessary to indicate research limitations that restricted the above-mentioned analyses. These limitations include a relatively small research sample that resulted from the lack of consent from companies to conduct quantitative studies. The lack of similar studies which describe such relationships also constituted a hindrance to conducting the analyses. Another research limitation was the difficulty in preparing analyses and formulating conclusions based on acquired results, however it did not prevent the performance of studies. It should be stressed that the analyses have an initial and ordering nature,

Figure 3
Graphic model of impact of Industry 4.0 technologies on the organizational culture of small companies

Source: Own study.

which gives an opportunity to develop further studies on a bigger research sample and observe phenomena related to the impact of the Industry 4.0 technology on organizational culture.

5. Conclusion

Despite the fact that the acquired results refer to a relatively small research sample, it is important to acknowledge that they might constitute an inspiration for the Industry 4.0 era managers and a foundation for initial modeling of organizational culture of companies. By purposefully choosing technologies that meet the requirements of the Industry 4.0 era, companies can try to model their cultural behavior, which is necessary to achieve their business goals in a long run. Therefore, the Industry 4.0 technologies can be seen as stimulants that not only impact but also create organizational culture. Moreover, it is possible to visualize traits and values of an organizational culture characteristic of the Industry 4.0 era and even to model them, which has been a challenge of the author's research work for several years. It seems that the presented results can play a significant role in building the Industry 4.0 era environment and serve as inspiring guidelines for management staff in terms of effective operation of their companies.

Endnotes

1   **Smart Factory** is understood as an intelligent production system that uses integration with cyber-physical systems and the Internet of Things, which operates mainly without human participation through generating, sending, receiving, and processing data necessary to carry out all tasks required to manufacture products.

2   The applied research method is one of the many used in the author's research and described in the doctoral dissertation.

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