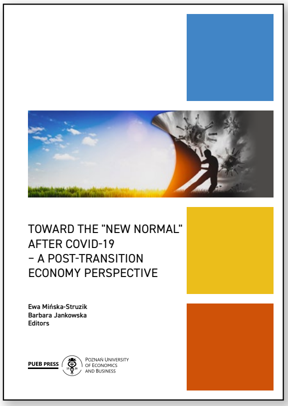

TOWARD THE "NEW NORMAL" AFTER COVID-19 – A POST-TRANSITION ECONOMY PERSPECTIVE

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1. The adoption of Industry 4.0 solutions as a remedy against the pandemic crisis – the case of Polish companies[1]

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Abstract

Purpose: The authors aim to briefly present the adoption of Industry 4.0 technologies among Polish companies in the realm of the VUCA world. These solutions may work as measures that increase the resilience of companies against the Covid-19 crisis and support the recovery in "the new normal" reality.

Design/methodology/approach: The paper combines literature studies with an empirical investigation in the form of computer-assisted telephone interviews conducted among 400 Polish manufacturing companies.

Findings: Polish industrial manufacturing firms lag in implementing I4.0 technologies compared to their Western European counterparts.

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Research limitations/implications: The empirical part of the study was conducted among Polish companies. Similar studies among firms from other CEE countries will be necessary to conclude about this part of the world's readiness to adopt 4.0 technologies.

Practical implications: The pandemic era and increasing I4.0 adoption pose particular tasks for companies. They should revise their contractual arrangements with IT service providers and focus on data privacy and security topics, but also industry-specific regulations. Triggered by the Covid-19 crisis, these actions may contribute to developing companies' comprehensive digital strategy in the "new normal" reality.

Originality and value: The chapter contributes to the discussion on the readiness of companies and economies to adopt the Industry 4.0 technologies. It also provides the level of the adoption of these solutions in the context of a post-transition economy.

Keywords: Industry 4.0, VUCA, Polish companies.

1.1. Introduction

The outbreak of the Covid-19 pandemic exemplifies the concepts of "black swan" or "wildcard" phenomena. The pandemic is an unexpected, sudden change in the companies' and societies' environment that leads to discontinuities and further to total disruption. Discontinuities may be defined as "rapid and significant shifts in trajectories without the aspect of being mostly unanticipated or deeply surprising," which extend "beyond single events" and radically alter "the previous pathways or expected directions of policies, events and planning regimes" (Saritas & Smith, 2011). The extreme shock delivered by the Covid-19 pandemic reflects the VUCA concept, that was mentioned in the Introduction to this book. The concept of VUCA - quite like the concept of strategy, comes from the military context and has permeated to the business world characterized by the growing turbulences (Millar, Groth, & Mahon, 2018). Heinonen et al. (2017) explain the term in detail. "V" stands for "volatility" that is to reflect the increased dynamics in many fields characterized by "changing directions of change." "U" represents "uncertainty" and signals a fundamental condition that decision-makers met in all ages that is related to the lack of knowledge. "C" means "complexity" that highlights a multitude of qualitatively different factors or elements that interact in many ways. "A" is short for "ambiguity" and reflects tremendous troubles we face to understand, interpret, and explain novel phenomena that, at first, often appear blurred. Ambiguous context provides confusion about what are the causes and what are the effects of a phenomenon.

The idea of turbulent environment is nothing new for business since it was highlighted many years ago by, among others, Igor Ansoff in his concept of corporate strategy (Ansoff & Sullivan, 1993). However, we notice today a greater diversity of factors facilitating turbulences and a greater intensity of these turbulences. They are strongly fostered by digitalization and technological change (Kaivo-ija & Lauraeus, 2018; Dercole, Dieckmann, Obersteiner, & Rinaldi, 2008), the spread of populistic strategies and policies among national governments (Hoekman & Nelson, 2018; Mudambi, 2018), the break-up of economic and political unions suchas Brexit (Thissen, van Oor, & McCann, 2020), the emergence of a new category of multinational companies from so-called emerging markets (Andreff, 2003; Buckley et al., 2007; Cantwell & Barnard, 2008; Hoskisson, Wright, Filatotchev & Peng, 2013; Frynas, Mol, & Mellahi, 2018, Ramamurti & Hillemann, 2018; Hernandez & Guillén, 2018), the increasing role of these markets in the global economy (Guercini & Runfola, 2016), and the entry of Generation Z to the market (Francis & Hoefel, 2018).

In this chapter, we aim to briefly present the adoption of Industry 4.0 technologies among Polish companies in the realm of the VUCA world since these solutions may work as measures increasing the resilience of companies against the Covid-19 crisis and support the recovery in "the new normal" reality when the VUCA dimension will cease. The way firms will cope with the VUCA environment, black swans, and wildcards seems to be determined by the digitalization and familiarity with the Industry 4.0 technologies. Thus, it is of tremendous importance for them – and for whole economies – not to stay in the position of a straggler.

1.2. Conceptual background: Industry 4.0 as the manifestation of VUCA

The fourth industrial revolution epitomizes to some extent the VUCA reality: "Industry 4.0 represents a smart manufacturing networking concept where machines and products interact with each other without human control" (Ivanov, Dolgui, Sokolov, Werner, & Ivanova, 2016). The term Industry 4.0 was initially formulated during the Hannover Trade Fair in 2011 and later adopted in other countries and regions that introduced different terminology: "Industrial Internet" in the USA and "Internet+" in the People's Republic of China (Wang, Wan, Li, & Zhang, 2016). Industry 4.0 (I4.0) reflects the novel approach to the industrial system in which happens the real-time connection of people, machines, and objects for the intelligent management of logistic-production systems (Melluso et al., 2020; Abonyi, Czvetkó, & Honti, 2020). According to Hermann, Pentek, and Otto (2015), the I4.0 is founded on four key sub-concepts: Cyber-Physical Systems (CPS), the Internet of Things, the Internet of Services, and Smart Factories. From a technical point of view, much of I4.0 is about digitalization and automation, which manifests itself in the exploitation of nine technology advances: Big Data and Analytics;

Autonomous Robots; Simulation; Horizontal and Vertical System Integration; The Industrial Internet of Things; Cybersecurity, the Cloud; Additive 3D Manufacturing; and Augmented Reality (Rüßmann et al., 2015).

Many companies are already implementing these technologies, but the level of their adoption and firms' readiness to implement them differs across countries. Kelkar (2019) studied 227 companies to indicate that 79% of manufacturing enterprises (any size) perceive Industry 4.0 as very important for their development. According to Computer Science Corp (2015), 63% of US manufacturing companies (900 in the sample) perceived Industry 4.0 as necessary for their further development. Dörfler (2019) conducted a study among 1849 German companies (regardless of the size and area of business), and 94% of them treated digitalization as important for their development. According to Mayer-Schönberger and Cukier (2014) the number of multipurpose industrial robots developed by enterprises in the 4.0 sector in Europe almost doubled. The International Federation of Robotics pointed to the highest robot densities in 2017 for the Republic of Korea (710), Singapore (658), and Germany (322) (QB Robotics, 2020). The number of installed industrial robots was calculated per 10,000 employees in the manufacturing industry. The world average was 85 robots per 10,000 employees. In 2013–2017, global sales of industrial robots grew by 114% (QB Robotics, 2020). The tendency to exploit robots in production, logistics, office management (for document distribution), maintenance, and repair of manufacturing defects is easily noticed (Kamarul Bahrin, Othman, Nor Azli, & Talib, 2016). However, in 2019 after six years of growth, the global robot installations dropped by 12% due to turbulences in the automotive and electronic industry caused by the tensions between China and the United States in 2018 (Executive Summary World Robotics 2020 Industrial Robots, 2020). The global economic crisis related to covid-19 pandemic will strongly impact the installations of robots. We may assume that in the short period the number of installations of robots may decrease but in the medium and long-term the digitalization facilitated by the pandemic will probably foster the growth of robots installations.

A Cisco study (2019) evaluates countries' readiness to create a digital economy using the Digital Readiness Index. This readiness is evaluated with an index. Since I4.0 is founded on digitalization, this index provides insights into how much particular countries are ready to absorb and exploit I4.0 solutions. This study developed a framework that points to key seven components crucial for the countries' digital readiness: basic needs, human capital, ease of doing business, business and government investment, start-up environment, technology infrastructure, and technology adoption. This model is holistic and does not refer only to technological factors. According to this study, the overall digital readiness scores ranged between 4.32 and 20.26 out of a maximum possible total of 25.

The overall average readiness score for 2019 was 11.90. The whole set of countries was divided into three subgroups: Amplify, Accelerate, and Activate. Presence in a particular subgroup is based on a country's score distance from the average result. The Active stage countries are the beginners with the lowest overall average score. The Accelerate stage countries are higher in terms of the overall average score but still have opportunities to upgrade their digital readiness. Countries in the Amplify stage are the most mature in terms of digitalization. The first position in the ranking (among 141 countries) according to the Digital Readiness Index for 2019 belonged to Singapore. This country scored more than 20 on the possible maximum score of 25. Poland ranked 33rd behind Czech Republic (25th) and in front of Hungary (39th).

1.3. Empirical research results

1.3.1. Industry 4.0 solutions adopted in Poland: Selected statistics and facts

According to the International Federation of Robotics (IFR), in 2015 in Poland were used 1795 new robots (an increase of 41% compared to 2014; Śmieszek, Dobrzański, & Dobrzańska, 2019). It resulted in the growth of the number of intelligent machines used in production of up to 8100. For these years, the robotization rate was about 27% (2015/2014) and it was faster than the world average (about 5%). The Poland's number of robots per 10,000 employees (the robotization density index) was 28, while the world average was 69 robots per 10 thousand employees, which in Europe last year even reached 92. In the abovementioned study conducted by Cisco (2019), Poland scored 14.94 and is at the Accelerate stage. Meanwhile, Poland's main business partner Germany achieved 17.85 and placed in the Amplify stage. Bearing that in mind and referring to the Digitization Index applied by the McKinsey Company, we clearly see the digitalization gap between Poland and Western European countries (McKinsey Company, 2016). This Digitization Index indicated a gap for the Polish economy at the level of 34%. For the sector of "advanced manufacturing" it was higher (45%) and even higher for the "simple manufacturing" sector, for which it reached as much as 78%. The World Bank Report "World Development Report 2016: Digital Dividends" presents the share of ICT in Poland's GDP at the level of 8%, and the sector employed about 430,000 people. However, ICT specialists accounted for only 3.1% of the workforce in Poland, while the EU average was 3.7%.

The Smart Industry Polska 2017 survey (2017) by the Millward Brown Agency conducted for Siemens in February 2016 on a sample of 100 people from the largest companies employing 250 people or more and operating in the manufacturing industry shows that the Polish manufacturing sector is ready for changes in terms of I4.0. Respondents indicated the following technologies typical of the Smart Factory: production line robotization – 56.7%; big data – 44.3%; M2M and the Internet of Things – 40.2%; data mining – 38.1%; cloud computing – 25.8%; RFID – 23.7%; and MEMS – 13.4%. Firms that participated in the study declared using the so-called demand-driven manufacturing (used by 46.4%); just-in-time delivery (used by 56.7%); lean management (used by 52.6%); supply chain management (used by 56.7%); the optimization of production processes (used by 82.5%); and quality management according to the concept of "zero defect" (used by 56.7%). More than one-third of the studied companies (35%) declared the possession of an innovative control system, which is fully automated and flexible. These perceptions are typical for large enterprises with foreign capital. Foreign subsidiaries established in Poland that participated in the study evaluated the level of modernity of applied solutions as at least seven on a ten-point scale (nearly 50% of them). This survey was conducted before the pandemic, so today over 60% of the studied companies plan to outsource work to universities or public research institutions, while nearly 57% of the firms pointed to the active cooperation with R&D institutions.

As far as robots are concerned more than 30% of Polish companies in the manufacturing sector at the beginning of 2020 planned to implement robots in the next three years (Poland robotics, 2020). International Federation of Robotics stated that Poland's robot density is expected to increase in the coming years. Nevertheless, the coronavirus crisis impacted the investment expenditures of companies and we still need to wait for data on that issue.

1.3.2. Industry 4.0 Solutions adopted in Poland: Selected primary study findings

1.3.2.1. Research methodology and sample composition

In the period from November 2019 to January 2020 – before the pandemic outbreak – we conducted computer assisted telephone interviews (CATIs) with 400 companies representing the whole manufacturing sector in Poland. We aimed to diagnose the level of I4.0 solutions adoption, find the inhibitors firms face while implementing I4.0 technologies, characterize them, and investigate their impact on the adoption of I4.0 technologies. The characteristics of the sample are presented in Table 1.

Table 1. Sample composition in terms of main variables

Factors	Description	Count	(%)
Firm ownership status	state-controlled firm	11	2.8
	private company	389	97.3
	the company is:		
	not listed on the stock exchange	376	94.0
	listed on the stock exchange	24	6.0
The ownership capital structure of the firm	100% of the Polish capital	305	76.3
	a minor share of foreign capital	82	20.5
	majority of foreign capital	13	3.3
The time range of the firm's operation in Poland	6–10 years	81	20.3
	11–15 years	139	34.8
	16–20 years	96	24.0
	>20 years	84	21.0
Headquarters home location	Poland	286	71.5
	Germany	37	9.3
	Others	77	19.2
Location of production activity in Poland	urban agglomeration	284	71.0
	outside urban agglomeration	116	29.0
The approximate number of full-time employees in Poland (in 2018)	from 10 to 49 employees	22	5.5
	from 50 to 249 employees	62	15.5
	from 250 to 499 employees	52	13.0
	500 and more employees	264	66.0
Exporting activities	no	41	10.3
	yes	359	89.8
All enterprises		400	100.0

Source: Own study results.

1.3.2.2. Brief study results

According to the research carried out just before the pandemic outbreak, Polish industrial manufacturing firms seem to lag in implementing I4.0 technologies compared to their Western European counterparts.[2] Figure 1 presents the frequency of use of eleven I4.0 solutions under scrutiny. Cybersecurity technologies and social media are the most widely used ones: by 97% and 58% of entities, respectively. This is relatively easy to explain because both technologies serve as tools to either secure firms operating in the digital environment or allow them to communicate with the market. More advanced solutions are implemented relatively seldom. Cloud computing is the third most-used I4.0 technology, but its adoption range is only half the size of cybersecurity solutions (43%) and 15 p.p. lower than social media. The fourth is simulation (digital twin), which 27% of firms often or very often use. Simultaneously, this solution is not used at all by 65% of enterprises. The scope of the use of the other seven solutions is minimal. In five cases, the scale of implementation does not exceed 20%, within which the potential of augmented reality remains unrecognized by 90% of respondents.

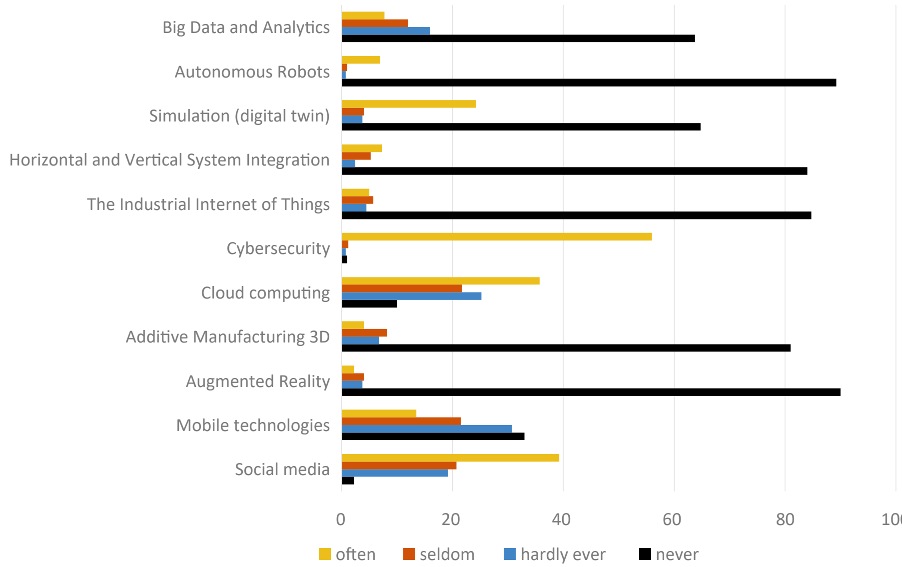

Figure 1. The adoption of I4.0 technologies (in percentage of interviewed companies)
Source: Own study results.

[2] More results of the study are presented in (Jankowska, Mińska-Struzik, Olejnik, & Bartosik-Purgat, 2020).

It would be worthwhile to test whether the pandemic spurred the use of I4.0 technologies or prevented further digitalization due to the sudden shortage of funds. Both scenarios are possible, with the latter being, in fact, more likely. Among barriers to implementing I4.0 technologies just before the pandemic, the interviewed firms stressed capital expenditures associated with the adoption of I4.0 solutions being prohibitively high. Financial constraints made it impossible to carry out capital investment and organize dedicated training needed for digital transformation. As much as 49% of respondents would expect any state support in this respect. Moreover, nearly one-third of enterprises encountered legal barriers related to implementing I4.0 technologies.

1.4. Conclusions

The VUCA reality looms for each company, and it became even more onerous since the emergence of black swans like the pandemic. The time of the pandemic and greater I4.0 solution adoption poses particular challenges for companies. They should revise their contractual arrangements with IT service providers and put data privacy and security topics high on the agenda, along with industry-specific regulations. These actions triggered by the Covid-19 crisis may contribute to the development of the companies' comprehensive digital strategy in the "new normal" reality.

Industry 4.0 technologies may contribute to the recovery and further development of companies. These solutions improve the visibility of real-time availability of resources – both tangible and intangible assets. They allow companies to smoothly reorganize activities since – thanks to artificial intelligence – companies may monitor their operations while robots support labor-intensive activities. Mobile technologies and augmented reality help workers to perform new tasks, which is important when companies face skills shortages. Mobile technologies, augmented reality, and the use of autonomous products like vehicles are extremely important in lockdowns since they allow for remote and virtual work and respect the social distancing requirement. This requirement means that companies may depend less on people, e.g. the use of 3D printing is useful when spare parts get stuck in the supply chain. The Industry 4.0 technologies contribute to the continuity and safety of people who work in production since simulation supports decision-making processes. Thanks to digitalization, the non-contact automated material transfer between cell stations along the production line may increase (Czifra & Molnar, 2020). The production process becomes more flexible. Three-dimensional printing technologies allow companies to switch production from one type of items to another, which provides them with more flexibility. The automation of production makes these processes more sustainable, which only gains from the flexibility that helps to cope with potential changes in the number of employees or shortages of raw materials that may emerge in the pandemic era.

Finally, we should mention that the implementation of I4.0 technologies is "a must" not only from the perspective of companies but also from the perspective of the economies that remain in the position of laggards in terms of digitalization and want to diminish their gap to the Western countries, which are more mature in terms of digitalization. Thus, while exploiting I4.0 solutions to combat the coronavirus crisis, companies and countries may climb up the ladder of digitalization.

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Part III
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