SILESIAN UNIVERSITY OF TECHNOLOGY PUBLISHING HOUSE

SCIENTIFIC PAPERS OF SILESIAN UNIVERSITY OF TECHNOLOGY 2023
ORGANIZATION AND MANAGEMENT SERIES NO. 181

INDUSTRY 5.0 AS THE UPGRADE OF INDUSTRY 4.0: TOWARDS ONE COMMON CONCEPT OF INDUSTRIAL TRANSFORMATION

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Purpose: Ten years after the introduction of Industry 4.0, politicians and scientists have started to promote the new concept of Industry 5.0. In this new concept, Industry 4.0 technologies are supposed to help companies achieve sustainability and resilience, and put people at the centre of technological change. This publication is based on a literature review. The topic of the analysis was Industry 5.0. The aim of the analysis was to present the research fields of researchers about Industry 5.0

Design/methodology/approach: Literature review was realized based on papers in data base Web of Science (WoS). The first paper was identified in 2016. After the year, there were more and more papers in the WoS data base. In the analysis, the method of SLR was used.

Findings: Based on realized analysis, the key research fields was identified. On the research fields, the discussion of Industry 5.0 was realized. The discussion was conducted in line with the three strategic directions for industrial transformation, which are written in the January 2021 EC document. These directions are: human at the centre of transformation, sustainability and resilience.

Originality/value: The key element of the paper is the matrix with research fields. In conclusion, the author states that due to the short period of industrial transformation, both concepts are industry changing. The concepts are difficult to separate from each other, so the author suggests using the term: Industry 4.0/5.0.

Keywords: Industry 5.0, Industry 4.0, Industry 4.0/5.0, industrial transformation, sustainability, humans, resilience.

Category of the paper: conceptual paper.

1. Introduction

The Fourth Industrial Revolution is popularising the fourth level of transformation - Industry 4.0 - the concept of using automation, digitisation, computerisation and smart manufacturing techniques in production processes and logistics. Industry 4.0 is an umbrella term for a number of techniques and principles for building smart solutions in companies and the value chain (Kagermann, 2015; Hermann et al., 2015). Enterprises 4.0 combines many technologies into cyber-physical systems with access to the Internet of Things (IoT). The result of Industry 4.0 is to be smart factories, with digital systems controlling production and logistics processes based on computer models. Over the Internet, the systems communicate machines with each other (M2M), machines with employees (M2P) and with business (M2B).

In the industrial transformation of companies towards smart manufacturing, influenced by the uncertain market situation in which companies find themselves after the pandemic period, politicians are calling on companies to improve their transformation approaches and tools. Introducing innovative thinking into companies and steering them towards the development towards Industry 4.0 has been complemented by the challenges enshrined in the new concept of Industry 5.0. This new concept sets out three key developments: the synergy of man and technology, sustainability and resilience (EC document, Jan. 2021). It can be assumed that both the idea of Industry 4.0 and the strategic challenges of Industry 5.0 are part of a common concept for the development of the industry (in Polish: *Przemysł Przyszłości* - the name of the Polish platform - przemyslprzyszlosci.gov.pl).

For some, Industry 5.0 is the result of next revolution (the Fifth Industrial Revolution), for others, an upgrade of Industry 4.0. Industry 5.0 is a concept addressed to manufacturers, as changes in factories are particularly visible, but also to many areas of human activities. The concept of Industry 5.0 is combined with the Japanese idea of Society 5.0, i.e. a society in strong synergy with high technologies and the global digitalisation of human activity – the strategy Japan's digitization (http://www.cebit.de/en/news-trends/news/society-5-0-japans-digitization-779). Society 5.0" - Super Smart Society - that was offered in 2016 by Japan's most important business federation, Keidanren and being strongly promoted by Council for Science, Technology and Innovation; Cabinet Office, Government of Japan (Nirmala, 2016).

The aim of this paper was to present the idea of the Industry 5.0 concept based on a literature review. The work consists of three parts. The first part is a consideration of the idea of Industry 5.0. In this section, strategic development directions are cited. The second part was based on the analysis of the Web of Science database on the topic: Industry 5.0. The scope of the analysis concerned publications about Industry 5.0 registered in the database in 2016-2022. The publications were organised according to the researchers' research fields. The result of the analysis is the matrix of research fields. The third part of the work is a scientific discussion of

the Industry 5.0 concept. The discussion was conducted in accordance with the three directions of transformation, as enshrined in the EC document (Industry 5.0 - ec.europa.eu, Jan. 2021).

2. Industrial transformation in the strategic directions of Industry 5.0

For more than a decade, there has been a discussion about the sense and substance of the next development concept, which the European Commission has called Industry 5.0 ('Industry 5.0' - ec.europa.eu). The discussion involves politicians, scientists and practitioners. In the course of the discussion, many arguments are raised in favour of popularising the next concept, as well as objections as to the sense of Industry 5.0 in the still-developing Industry 4.0. Some scientists assume that Industry 5.0 is a refinement of the Industry 4.0 concept, and some that it is the result of the Fifth Industrial Revolution (Skobelev, Borovik, 2017). According to Matthews (2018) "Industry 5.0 takes the automated and efficient concepts of Internet of Things and big data and injects them with a traditional, personalized human touch". In discussions, scientists and politicians mainly focus on the thesis that Industry 4.0 is all about technology and Industry 5.0 is a concept that sets (organises) the directions of industrial transformation (Gajdzik, 2023). Such a thesis is just a rather popular myth - a statement made by D. Kwiek (2022). In reality, the meaning of the Fourth Industrial Revolution is changes far deeper than technological, i.e. involving the improvement of organisations, the introduction of new business models and the placement of the employee at the centre of technological change. Nevertheless, the European Commission's concept of *Industry 5.0 towards a sustainable, human-centric and resilient European industry* has reminded companies of humanity, the environment and stability. After the COVID 19 pandemic, new thinking about industrial transformation began. According to Skobelev and Borovik (2017) "Industry 5.0 involves the penetration of Artificial Intelligence in man's common life, their "cooperation" with the aim of enhancing the man capacity and the return of the man at the "Centre of the Universe". In Industry 5.0, humans are strongly connected to technologies. Human collaborates and co-exists with Industry 4.0 technologies (Rada, Linkedin). According to Alves et al. (2023) Industry 5.0 is attributed to the Fifth Industrial Revolution. The transition from the Fourth Industrial Revolution to the Fifth is also being considered by Xu et al. (2021). Many researchers and practitioners agree that the technologies of the Fourth Industrial Revolution have not yet built Industry 4.0. The transformation of industry to Industry 4.0 is still ongoing (Xu et al., 2021). For many industries, adapting to the changes of the Fourth Industrial Revolution can still be challenging (Gajdzik, Wolniak, 2022; Gajdzik, 2021, 2022; Lorenz et al., 2015). Since the first industrial revolution began in the 19th century, however, progress has not come to a standstill. Centuries invested in new devices and more technologically advanced equipment have given rise to a new development concept called Industry 5.0. We are now in the midst of a cyber revolution, often

known as Industry 4.0 (Matuszak, 2022). Longo, along with co-authors (2020), considers Industry 5.0 as a new revolutionary wave that is emerging as the "Age of Augmentation", when man and machine will reconcile and work in perfect symbiosis with each other (2020).

The interesting concept of Industry 5.0 is commented on by the I-scoop website founded by J-P De Clerck. In the article entitled. 'Industry 5.0 - the essence and reasons why it gets more attention', we read: Industry 5.0 should not be combined with the next industrial revolution, that would be completely wrong (https://www.i-scoop.eu/industry-4-0/industry-5-0/). In the United States, the term Industrial Internet of Things (IIoT) is often used instead of Industry 4.0. In Japan, on the other hand, Industry 4.0 is embedded in the concept of Society 5.0. Carloty Perez states that everything is relative and that industrial revolutions today are a matter of vision. Since Industry 4.0 is sometimes perceived as a 'cool' concept of development, therefore attempts are being made to give it a more 'human' face.

Grabowska et al. (2022) emphasise that social aspects are regaining their rightful place in Industry 5.0. Industry 5.0 is the reintroduction of people into industrial infrastructure and production and logistics processes (Saniuk et al., 2022). Industry 5.0 is strongly linked to Society 5.0 (Soltysik-Piorunkiewicz, Zdonek, 2021). People and machines are reconnecting and collaborating to achieve new production efficiencies and quality of life. The 'human touch' has become an important strategic direction of Industry 5.0. In Industry 5.0, robots are to accompany humans and improve production processes The collaboration of humans and computerised machines will significantly improve the optimisation and automation of many enterprises. The concept of 'human touch' to industry is to increase the degree of collaboration between humans and intelligent production systems. Such a marriage is expected to bring together the best of two worlds - the speed and accuracy guaranteed by automation with the cognitive skills and critical thinking of humans (Nahavandi, 2019).

The development of Industry 5.0 is identified with artificial intelligence and the potential to significantly deepen the interaction between humans and machines. Advances in deep learning are bringing factories closer to realising the vision of smart factories (Friday, 2018). Collaboration between technology and people will result in new techniques and ideas and contribute to reducing waste and costs. Sustainability is a strong strategic direction for industrial transformation (Gajdzik et al., 2020). Unfortunately, Industry 4.0 does not have a strong focus on environmental protection, nor has it focused technologies to improve the environmental sustainability of the Earth, even though many different AI algorithms have been used to investigate from the perspective of sustainability in the last decade (Nahavandi, 2019; Alzoubi et al., 2019). In Industry 5.0 linking AI algorithms with environmental management is the new way of industrial transformation. Industry 5.0 leads to the better technological solution to save the environment and increase sustainability. Expanding on research about Industry 5.0, experts reiterate well-known assumptions about the circular economy, ecology, green energy, realising people's needs without compromising the same needs of future generations, and highlight the potential of AI in optimising the consumption of goods. According to A. Komoli

with Sumitomo Bordnetze (https://www.production-manager.pl/2020/02/03/industry-5-0-przyszlosc-ktora-juz-istnieje/): Industry 5.0 will be associated with more advanced analytics using machine learning, (again) artificial intelligence and new systems and blockchain. Also Z. Piątek (2018) in AutomationB2B argued that Industry 5.0 could possibly be attempted to be combined with the potential of AI and the deepening of human-machine interaction using machine learning. The common denominator of all these discourses is the hopes of leapfrogging AI affecting both data analytics and communication between workers and devices (in all configurations).

Technology is supposed to help companies acquire resilience. Researchers formulate the question: what can technology do for stability (Maija Breque, Lars De Nul, Athanasios Petridis: www.research-and-innovation.ec.europa.eu). Resilience is to be in the happening geopolitical changes, crises, pandemics and other changes due to the fragility of globalised production.

It can be assumed that the technologies building Industry 4.0 are the base in the changes taking place, and the strategic directions of development enshrined in the concept of Industry 5.0 are the superstructure over the technological changes already taking place. In Industry 4.0 there are usually identified four key components: CPS, Internet of Things (IoT), Internet of Services (IoS), and Smart Factory and six major technologies: the Industrial Internet of Things (IIoT) and CPPS, additive production (3D - the printing), Big Data, an artificial intelligence (AI), Collaborative Robots (CoBot) and the virtual reality (Skobelev, Borovik, 2017). Industry 5.0 there are three strategic directions of industrial transformation: human-centric, sustainable and resilient. The outcome of Industry 4.0 is CPSs, which will achieve autonomous in Industry 5.0 at the manufacturing level. In addition, personalisation will continue to develop to help consumers use products better. In Industry 5.0 there are a lot of technologies linked with personalization or creative production. Technologies are the best fit for applications or services where a personalized and human touch provides better customer experience (Ozdemir, Hekim, 2018).

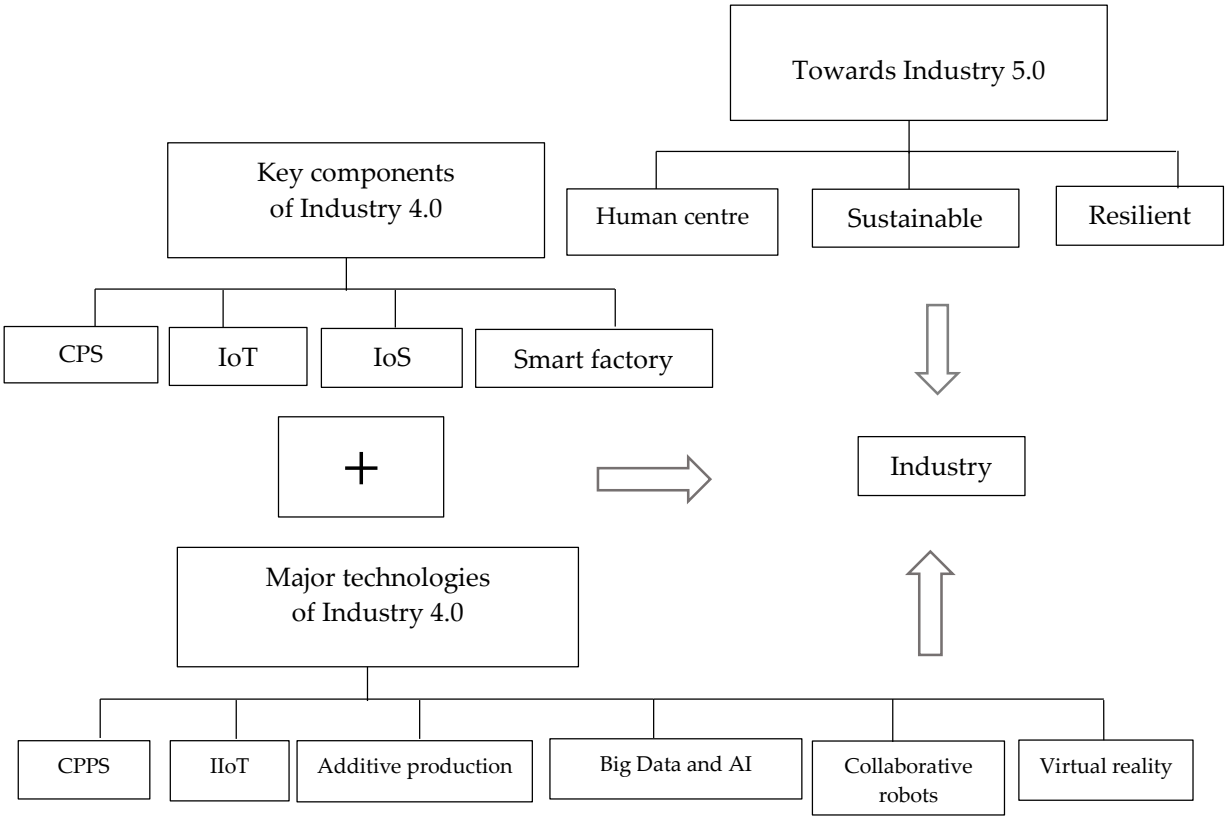

Figure 1. Towards one concept Industry 4.0/5.0.

Source: own elaboration (Gajdzik, 2023).

European Industry 5.0 is constantly being improved. In September 2020, the European Commission published a paper by J. Müller entitled: 'Enabling Technologies for Industry 5.0. Results of a workshop with Europe's technology leaders'. The paper contains an early proposal of the Industry 5.0 concept, describes the technologies relevant to this phase and identifies social, governmental, political and economic challenges. In turn, following the 'Industry 5.0' report of January 2021, the EC published even a year later yet another study 'Industry 5.0, a transformative vision for Europe. Governing Systemic Transformations towards a Sustainable Industry'. The document, created by 15 authors led by Sandrine Dixson-Decleve, is a step between a comprehensive definition with 'Industry 5.0' and the development of a roadmap for realising the concept. Industry 5.0 will be the era of machine learning and artificial intelligence, the era of data and learning from it. But it will also be a time of new systems.

Technological developments are already making it possible to create systems that will not be based on classic databases, but on interconnecting objects. Systems will only define connections that can be stored using the blockchain idea, which is gaining popularity in production systems. This will certainly be the next big revolution for businesses. As the current revolution is not yet properly implemented and utilised, it remains to be hoped that we will prepare much better for the next one and start the process of adapting businesses to new challenges much earlier (Komolka, 2019).In time, companies and people will better understand the idea of Industry 5.0 as a vision of development for a new quality of life and business.

3. Research fields of Industry 5.0 based on literature review

The methodology was carried out, based on scientific publications registered in the Web of Science (WoS) database, on the topic of the study on Industry 5.0 (the keyword Industry 5.0 was used to search for publications). The first publication on Industry 5.0 (2016) was taken as the start of the analysis. The analysis was closed at December 2022. The number of publications was analysed in each completed year. The result of the analysis was the matrix of research fields (Table 1 and Table 2).

Table 1.
Matrix of Industry 5.0 research fields based on papers in the WoS database

Year	Number of papers	Research fields	Source
2016	1	*Author keywords*: socio-economic development, industrial engineering, relevance virtual evolution	Sachsenmeier, 2016
2017	0	-	-
2018	2	*Author keywords*: Society 5.0, full automation, IoT, Big Data, ecosystem, embedded strategy, networks, social aspect, transformation, humanisation, ethical aspect, changes, development strategy, industrial policy, social governance, artificial intelligence (AI), technology policy.	Kang, 2018; Ozdemir, Hekim 2018.
2019	4	*Author keywords*: Society 5.0, technological development, cooperation robots and human, human-centre, digital processing, sensors, IoT, enabled data Smartphone, wireless data acquisition, signal processing, artificial intelligence (AI), advanced manufacturing.	Nahavandi 2019; Salimova et al. 2019; Hamdani et al. 2019; Fitzgerald et al., 2019.
2020	11	*Author keywords*: value, human-centric, technology engineering, COVID-19, innovation, IoT, manufacturing, ethical engineering, operator 4.0, Industry 4.0, Society 5.0, open innovation, value co-creation, big data, artificial intelligence, advance technologies, digital innovation, personalization, Absolute Innovation Management (AIM), design thinking, innovation management, strategy, innovation ecosystem, competitive advantage, economic development, implementing innovation, innovation framework, capabilities, manufacturing, complex adaptive systems, self-organization, digital platform, digital ecosystem; Multi-agent technology, smart services, resource management, fourth industrial revolution, sustainable development, sustainability, sustainable development goals –SDGs.	Longo et al., 2020; Javaid et al. 2020; Aslam et al. 2020; Javaid, Haleem, 2020; Aquilani et al., 2020; Gorodetsky et al. 2020; John et al. 2020; Monteiro et al., 2020; Sherburne 2020; Salimova et al. 2020; Nwogugu, 2020.

Cont. table 1.

2021	29	*Author keywords*: Society 5.0, balance, social aspects, changes, economic advancement, manufacturing, IoT, AI, enabling technologies, industrial revolution, Industry 4.0, technology, value, Corporate Social Responsibility (CSR); socially responsible economic advancement, social problems, industry, bioenergy, engineering, Sustainable development goals (SDGs), green IoT, IIoT, edge computing, edge AI, sustainability, digital transition, digital circular economy, smart society, digitalized society, fusion energy, open data, cluster analysis, visualization, evolution, RIFD, communication, technological competitiveness, emerging economies, digitalization, emerging technology use, Blockchain technology, automated analytics, Cyber-Physical Systems (CPSs), design automation, system synchronization, DVFS control, Ccollaborative robotics, manufacturing, business intelligence systems, sustainability, data, common-sense capability, machine learning, 6G, blockchain, Cyber-Physical-Social Systems (CPSS), Internet of No Things, on-chaining, oracles, Robo-nomics, tactile Internet, human capital, employee assessment, labor performance, individual trajectories of professional development, organizational innovation, knowledge society, Cyberloafing, Industrial Revolution 4.0, Human-Robot Collaboration (H-RC), digital platform, ambient assisted living, ambient intelligence, enhanced living, environments, ecosystems, networks, communities, edge computing, advanced technologies, business models, value chain.	Top(*) Potocan et al., 2021; Xu et al., 2021; Maddikunta et al., 2021; Zengin et al., 2021; ElFar et al., 2021; Fraga-Lamas et al., 2021; Carayannis et al., 2021; Soltysik-Piorunkiewicz, Zdonek, 2021; Rupa et al. 2021; Di Nardo, Yu, 2021.
2022	87	*Author keywords*(*): digital, social innovation, Society 5.0, digital transformation, digital green innovation, manufacturing industry, cognitive evaluation, enterprise performance, human-centric manufacturing, industrial human needs pyramid, self-organizing manufacturing, human-machine relationship; Human-centric human-robot collaboration, 6G mobile communication, industries, optimization, automotive engineering, green transportation, backscatter communication, nonorthogonal multiple access (NOMA), vehicular networks, artificial intelligence (AI), smart manufacturing, big data, Internet of Things, human-machine coexistence, 21st century skills, engineering education, higher education, smart environments, knowledge circulation, innovation ecosystems, techno-centric and human-centric innovations, 6G, edge computing, enabling technologies, pervasive AI.	Top(*): Akundi et al., 2022; Maddikunta et al., 2022; Carayannis et al., 2022; Broo et al., 2022; Kaur et al., 2022; Khan et al., 2022; Lu et al, 2022; Yin et al., 2022; Carayannis, Morawska-Jancelewicz, 2022.

Top(*) only papers with the highest citations: time of citations in WoS, author keywords (*) only with Top list.

Source: own elaboration.

In the next table (Table 2), the research fields of the scientists from Table 1 are arranged according to four areas: (1) technological changes, (2) sustainable and digital development, (3) human-centric (4) resilience and CSR.

Table 2.
Segments of research fields about Industry 5.0

Segment	Research fields
Technology and industrial transformation	industrial engineering full automation, IoT, Big Data, networks, industrial transformation, artificial intelligence (AI), technology policy, technological development, digital processing, sensors, enabled data Smartphone, wireless data acquisition, signal processing, advanced manufacturing, technology engineering, innovation, Industry 4.0, manufacturing, advance technologies, digital innovation, personalization, Absolute Innovation Management (AIM), design thinking, innovation management, manufacturing, complex adaptive systems, self-organization, digital platform, digital ecosystem; Multi-agent technology, smart services, resource management, fourth, enabling technologies, industrial revolution, Industry 4.0, technology industrial revolution, IIoT, edge computing, edge AI open data, cluster analysis, visualization, evolution, RIFD, communication, technological, Blockchain technology, automated analytics, Cyber-Physical Systems (CPSs), design automation, system synchronization, DVFS control, collaborative robotics, manufacturing, business intelligence systems, machine learning, 6G, blockchain, Cyber-Physical-Social Systems (CPSS), Internet of No Things, on-chaining, oracles, Robo-nomics, tactile Internet, digital platform, ecosystems, networks, communities, edge computing, advanced technologies, self-organizing manufacturing, 6G mobile communication, industries, optimization, automotive engineering, backscatter communication, nonorthogonal multiple access (NOMA), vehicular networks.
Sustainable and digital development	socio-economic development, Society 5.0, ecosystem, embedded strategy, social aspect, changes, development strategy, industrial policy ,social governance, strategy, innovation ecosystem, economic development, implementing innovation, innovation framework, capabilities, sustainable development, sustainability, sustainable development goals –SDGs, balance, social aspects, changes, economic advancement, bioenergy, engineering, Sustainable development goals (SDGs), green IoT, sustainability, digital transition, digital circular economy, smart society, digitalized society, fusion energy, Cyberloafing, Industrial Revolution 4.0, business models, value chain, sustainability, digital and social innovation, Society 5.0, digital transformation, digital green innovation, manufacturing industry, cognitive evaluation, enterprise performance, green transportation, techno-centric and human-centric innovations, 6G.
Human-centric	humanisation, cooperation robots and human, human-centric, operator 4.0, human capital, employee assessment, labor performance, individual trajectories of professional development, organizational innovation, knowledge society, Human-Robot Collaboration (H-RC), human-centric manufacturing, industrial human needs pyramid, human-machine relationship; human-centric human-robot collaboration, human-machine coexistence, 21st century skills, engineering education, higher education, techno-centric and human-centric innovations.
Resilience and responsibility	relevance virtual evolution ethical aspect, responsible value , COVID-19 ethical engineering ,open innovation, value co-creation, competitive advantage, Corporate Social Responsibility (CSR); socially responsible economic advancement, social problems, competitiveness, emerging economies, digitalization, emerging technology use, common-sense capability, ambient assisted living, ambient intelligence, enhanced living, environments, smart manufacturing, smart environments, knowledge circulation, innovation ecosystems, edge computing, enabling technologies, pervasive AI.

Source: own elaboration.

In future studies, these research fields will be analysed using computer programmers. The future analysis will focus on the ordering of fields for Industry 5.0. After further ordering, the author intends to continue conceptual research about Industry 5.0.

4. Discussion

The Industry 4.0 view is the implementation of various new technical solutions into business entities especially in production to increase their level of innovativeness and effectiveness. But as we can observe in many companies not always the effectiveness on tactical level is connected with effectiveness on strategic level of company (Miyake, 2022; Sultan et al., 2021). Sometimes the company can implement new technological solution but it's effectiveness will not increase in long term due to lack of strategical view, strategical thinking and strategical approach. The tactical level is something between Industry 4.0 and Industry 5.0 – on this level we can observe many activities connected with both of those conceptions. Fig. 2 presents the place of Industry 4.0 and Industry 5.0 from level of management point of view.

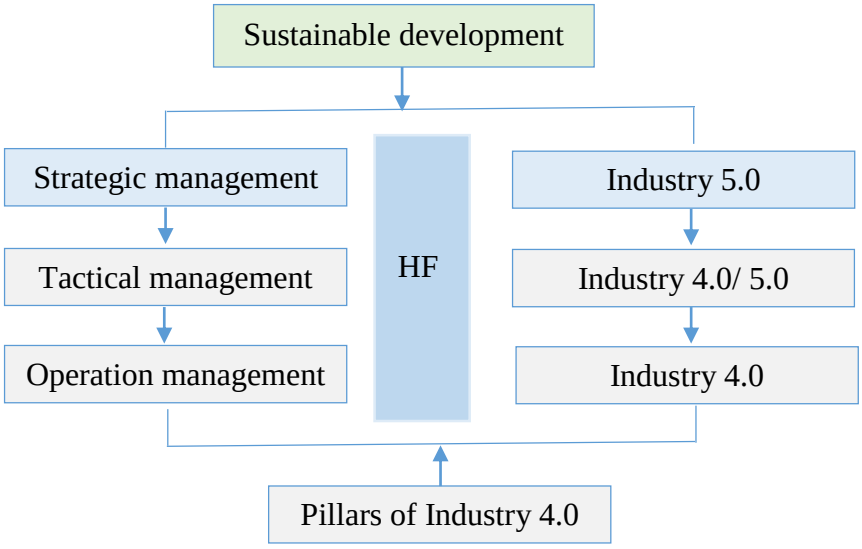

Figure 2. The model of relation Industry 5.0 and Industry 4.0 with management levels.
Source: Wolniak, 2023.

The first new aspect connected to Industry 5.0 is the human approach to business problem. All business today should take into account problems connected with human (Carayannis et al., 2022). This approach means that organization should take into account the cultural aspect of business like the type of country and organizational culture, the type of leadership, etc. Organization should promote diversity, talents and empowerment in business. Some researches point out that diversity could be for example very beneficial for innovation point of view and boast level of innovativeness of organization (Adel, 2022).

Many of Industry 4.0 pillars are strictly connected with human centric strategic approach of Industry 5.0. For example the people in the company and their attitude and behavior plays important role in achieving the appropriate level of cybersecurity within the company. According to Pawlicka (2022) the human aspects are one of most important when we analyze cybersecurity problems. Authors thinks that cybersecurity can be achieved using appropriate human management. The main problem with cybersecurity is connected with lack of thinking

about human factors in security and eradication of human related issues. According to him the educational system should concentrate on increasing the value of human factors among informatics working in cybersecurity area. Organization should adopt culture towards cybersecurity by boasting appropriate behaviors of people (Pollini, 2022). Upadhyay (2022) has found that the better cybersecurity needs people with personality traits which can positively impact on this phenomenon. Finding and managing peoples with those traits is very important task for human resource department in Industry 5.0 condition.

Also there is a need to learn humans how to collaborate with robots – in some companies we can observe increasing role of so called cobots – autonomous robots working with humans (Spatz, Langstrof, 2022; Ahmed et al., 2022; Weiss et al., 2021). The increasing role of cobots as Sorell thinks (2022) can replace the unskilled human labor but for now the artificial intelligence is lacking "soft skills". Those soft skills are specific for human beings and can give worker or manager comparative advantage in company. Agarwal and Chauhan thinks (2022) that creating co-working space for humans and cobots can be beneficial for the industry especially inn e-commerce.

The humans plays very important role in integration of all vertical and horizontal processes in company. Without the broad strategic, human centered approach the integration is not possible. The increasing complexity of management processes in Industry 5.0 conditions needs system approach. The integration of technical and human aspects of the company is a key to organizational success in today market. This integration can be very beneficial for a company it can lead to better relation within organization, organizational culture better adjusted to Industry 5.0 and the decrease of wastes within organization (Cillo et al., 2022; Taverner et al., 2021).

Also the augmented reality is very closely related with human labor. The human using augmented reality solution will have possibility to increase its effectiveness knowledge and those solution will help works in many operations in business (Harborth, 2022). Using augmented reality can be a possibility to develop new interactive system which can increase the innovativeness of humans. Augmented reality can be used to achieve safe condition for human for example it is useful in chemistry industry (Bartra et al., 2022). To achieve the full potential of augmented reality we should to think about the adaptability of humans to new technology. It is not always easy process and needs learning the people new skills and preparing them to new working conditions (Wang et al., 2022).

The second pillar of Industry 5.0 is connected with sustainability. From the today business point of view the business should be focused not on short term approach but on long term sustainable business approach (Ivanow, 2022). In Industry 5.0, the sustainability is a coexistence of humans and machines (Johri et al., 2021). The sustainability is very closely related with Corporate Social Responsibility and Social Responsible Economics. All industrial organizations are connected with sustainable development. The concept is still connected with circular economy but now is supported by intelligent products, automation, autonomous robots,

blockchain etc. The sustainable approach needs integration of many aspects of the company according to pillars of Industry 4.0. Zeghda (2021) points out that in digital economy we need cybersecurity to control sustainability in production enterprises. The cybersecurity is needed to ensure correct operations of the entire system and it leads to ensuring safety of its components (D'adamo, 2021). Salam describes (2020) the relations between sustainability and Internet of things. The author says, that the sustainability of Internet of Things implementation should lead to better cybersecurity. The main problems related with sustainability of Internet of Thinks are connected with: reducing the amount of waste, reducing energy consumption and improving air quality (Mustonen, 2021). Internet of Things can improve the production processes by monitoring environmental indicators or operating towards decreasing of wastes (Maqbool et al., 2022; Blumenthal and Diamond, 2022). Also the widespread of simulation methods can lead to better sustainability. Simulations can lead to decrease of amount of waste, analyze of carbon footprint, raw material usage, energy intensity and other aspects of the processes (Visual, 2022; Moran et al., 2023; Bello et al., 2022).

The last pillar of Industry 5.0 is resilience. The resilience is connected with the better robustness of supply chain which will guarantee that the key infrastructure will function in times of crisis (Ivanow, 2022). Especially in times of COVID-19 pandemic it could be observed the value of resilience of supply chains (Ullah et al., 2022). Trust built up over years in supply chains (Gajdzik, Grzybowska, 2012) has proved insufficient during a pandemic, and people need to rely on the capabilities of technology, which should alert them and inform them of the symptoms of a pandemic. Many organizations, because of continuous lockdown have problems with the supply and should to stop their operation (Juan, Li, 2023; Adana et al., 2023). After COVID-19 pandemic the topic of resilience was not main topic among business science, but the crisis start to change in this view (El Baz, Ruel, 2021; Cuvero et al., 2021). Now the resilience can be viewed as one of main concept on the level of strategic management and because of that it is implemented in new Industry 5.0 approach.

5. Conclusion

The world of technology, mass customization and advanced manufacturing is undergoing a rapid transformation. Industry 4.0 is a high-tech manufacturing automation strategy that leverages IoT to create the Smart Factory. Industry 4.0, an initiative of Germany, has become a globally accepted term over the past decade. Many countries have introduced similar strategic initiatives, and significant research efforts have been devoted to the development and implementation of some Industry 4.0 technologies. On the tenth anniversary of Industry 4.0, the European Commission announced Industry 5.0. In the new development concept, Factories of the Future will be more strongly oriented toward people, values and ethics. Although

manufacturing companies are currently at a transition point between Industry 4.0 and Industry 5.0, a new age of industry is already emerging. Using the nomenclature of Longo et al. (2020) this is the "Age of Amplification" of the role of technology vis-à-vis humans and complex social, economic and environmental problems. Industry 5.0 will emerge when man and machine reconcile and work in perfect symbiosis with each other. Industry 5.0 is an upgrade for Industry 4.0. The two concepts complement and integrate each other. The time of change between Industry 4.0 and Industry 5.0 (one decade) is too short for each to be the result of a separate industrial revolution. For these reasons, Industry 4.0/5.0 was used in the topic of the paper. Combining the two concepts makes sense because Industry 4.0 technologies are the basis for the development of Industry 5.0, which points to three key strategic directions for industrial transformation: human, sustainability and resilience.

Acknowledgements

Source of payment: 11/040/BK_23/0029.

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