“Industry 5.0 as a human-centric direction for social and labor entities transformations”

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INDUSTRY 5.0 AS A HUMAN-CENTRIC DIRECTION FOR SOCIAL AND LABOR ENTITIES TRANSFORMATIONS

Abstract

The interaction of humans with artificial intelligence and cyber-physical systems opens the way to understanding the role of humans in modern industrial ecosystems. The research purpose is to examine the roles and functions of humans in implementing Industry 5.0 through the analysis of personality transformations in social and labor entities. A structured review methodology that synthesizes existing research on Industry 5.0 as a human-centric direction using systematic and transparent procedures (framing the question, identifying relevant publications in the Scopus database, summarizing the evidence, and interpreting the findings) is used. Within Industry 5.0, the physiological needs of a bio-human (needs for food, water, living conditions, etc.) and the technocratic interests of a labor-human (the desire to earn money, career growth, prestige, etc.) are overwhelmed in terms of time and effort by the socio-human personality needs (intellectual development, the realization of creative abilities, and obtaining knowledge). In complex technical tasks and strategic decision-making processes, humans continue to play a key role, emphasizing that full automation is not possible in all areas, and a human-centric approach remains the basis of production systems. Among the key personality skills needed for Industry 5.0 are analytical and creative thinking, the ability to design technology, critical thinking, ability to solve complex problems, leadership skills, emotional intelligence, and generating new ideas. Industry 5.0 promotes the consumption of mainly information and services dictated by the informational (spiritual) nature of the personality and relatively depresses the use of materials and services, dictated by the material nature of the human-bio.

Keywords industrial revolution, Industry 5.0, human personality, transformations

JEL Classification O33, M21, Q55, J24

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INTRODUCTION

There is growing interest in the concept of Industry 5.0, which expands the technology-oriented narrative of Industry 4.0 by emphasizing people, sustainable development, and the resilience of industrial systems (Breque et al., 2021). The timeliness of this scientific search is confirmed by the growing number of interdisciplinary studies aimed at identifying the humanistic dimensions of technological progress, as well as at forming socio-ethical principles of human-technology interaction (Van Erp et al., 2024; Nasir et al., 2025). The need for such studies is also driven by the European Union's strategic priorities, which focus on developing an inclusive, sustainable, and human-centered knowledge economy. At the same time, there is an observed methodological gap. The majority of research focused on external, instrumental aspects, such as technological architecture, digital platforms, cyber-physical systems, model management, and environmental stability production (Lu et al., 2022; Adel, 2022). In contrast, internal personal transformations (e.g. valuable orientations, identities, motivations, and psychological strategies for adapting to cooperation with

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technological systems and artificial intelligence) have been developed less (Briken et al., 2023; Li et al., 2023). Such diverse methodological approaches complicate the formation of agreed concepts of human-centered industrial revolutions. The above publications highlight the current challenges of implementing Industry 5.0 as a human-centric phenomenon; however, researchers have not adequately addressed the transformation of the personality essence as the primary actor and driving force behind the events.

1. THEORETICAL BASIS

The Swiss economist Klaus Schwab treats the Industrial Revolution as a transformative socio-economic phenomenon (Schwab & Davis, 2018). In particular, the agrarian revolution initiated labor activity, and instead of gathering and hunting, man began to engage in purposeful production of the necessary means of subsistence. The man himself turned into a triune entity that integrated the biological, personal, and labor principles (Arnold, 1993; Braidwood, 1960). The first Industrial Revolution provided humans with machines as labor tools and led to the mechanization of physical human labor (Alvarez-Palau et al., 2025; Crafts, 2011). The second Industrial Revolution marked the emergence of industrial production as a distinct system. The second Industrial Revolution key features were mass production of standard goods and mass consumption of standardized products and services; high material and energy intensity of production, storage and transportation of goods; use of a new high-quality type of energy (electricity) with the removal of the processes of obtaining electricity themselves outside the scope of production operations; constant growth of informatization of production etc. A person typically becomes an industrialized entity, characterized by specialization of activity, a high level of education (even in agriculture), advanced capital equipment, and a predominantly urban lifestyle (Melnyk et al., 2019; Jevons, 1931).

The third Industrial Revolution, which began at the turn of the 20th and 21st centuries, brought about a significant increase in production efficiency, the development of alternative energy sources, and additive technologies, driven by the miniaturization of production facilities and the informatization of economic systems (Rifkin, 2008; Taalbi, 2019). However, the main thing (usually paid less attention to) was the emergence of reasons for changing a person's social status. Distributed (horizontal) production systems in energy and industry create conditions for a person to transition massively from a hired worker to the owner of the means of production and an active participant in a solidarity economy (Melnyk et al., 2021). The Internet not only gave individuals the ability, in terms of efficiency, to connect to a single global information field, but also transformed them into network entities. Additionally, Grigoryan et al. (2025) demonstrated statistically reliable opportunities for increased efficiency in AI use for HR management within the ICT sector.

The fourth Industrial Revolution promises to be an unprecedented phenomenon in terms of the scale of automation, self-organizing cyber-physical systems, based on the Internet of Things and artificial intelligence that form the foundation of this revolution. They are under the control of the "Cloud", freeing people from the need for direct participation in the production process (Parra-Sánchez, 2025; Batra et al., 2025). At the same time, millions of people are losing their usual jobs, as Industry 4.0 significantly increases production efficiency and creates the prerequisites for solving many technical (Nagy et al., 2019), economic, and environmental problems (Martínez-Ardila et al., 2025), while serious social challenges are beginning to emerge. The solution to controlling cyber-physical systems, which are self-organizing, self-replicating, and equipped with artificial intelligence, remains unclear.

Industry 5.0 presents significant challenges ahead, and preventing problems is often more effective than trying to eliminate them. In other words, to find the necessary solutions so that possible problems do not arise at all or are significantly mitigated. It is no coincidence that the concepts of Industry 4.0 and Industry 5.0 matured almost simultaneously. The concept of implementing Industry 4.0 was first expressed by politicians, scientists, and people in business in Germany in 2011 (Schwab & Davis, 2018). The term "Industry 5.0" first appeared in 2015 (Rada, 2018), and in 2019, the "Industry 5.0" department was established

within the European Commission's Science and Innovation Directorate. Perhaps the most pronounced and comprehensive difference between Industry 4.0 and Industry 5.0 was expressed by Lindsay and Hudson (2019): if Industry 4.0 seeks ways to increase efficiency or productivity, then Industry 5.0 attempts to find answers to the question of how to make the world better for humans.

The current academic discussion on Industry 5.0 focuses on three interrelated dimensions. The first is human-centricity, which involves the safety, well-being, and professional development of workers. The second is sustainable development aimed at minimizing ecological impact and implementing circular production models (Brückner et al., 2025). The third is resilience, which ensures the ability of industrial chains to adapt to global challenges and shocks. These approaches are reflected in both EU position papers and numerous empirical and survey studies (Lu et al., 2022; Alves et al., 2023; Van Erp et al., 2024). In recent years, a significantly increased number of research studies have systematized the concept of human-centric manufacturing, offering conceptual models and technological frameworks for human-cyber-physical system interaction. In particular, Lu et al. (2022) developed a conceptual model that takes into account employee needs and technological requirements for effective "human-machine" collaboration. Alves et al. (2023) conducted a systematic review and critically assessed how much Industry 5.0 truly puts people at the center of industrial transformations. Tóth et al. (2023) proposed an architecture for integrated cooperation between human and artificial intelligence in manufacturing processes, providing a solid foundation for further analysis of the socio-psychological aspects of Industry 5.0. Taking into account the conceptual framework that has been formed in the literature, a socio-person, or personality, can be defined as a stable system of socially significant characteristics that characterizes an individual as a subject of social relations and conscious activity (Back et al., 2023; Sugimura et al., 2025; Crocetti et al., 2023).

The basis of personality formation is a person's ability to perceive and reflect (process, assimilate, and consolidate) information from the environment. Inseparable parts of a single process of reflecting reality are sensation, perception, memory, imagination, and thinking. To be more specific, according to Cherry (2019):

- feeling is a reflection of individual properties of objects that affect senses;
- perception is the formation of object images based on reflected reality;
- memory is the reflection and recording of experience;
- preservation and reproduction of information is forming an image of the future based on experience;
- thinking is the highest form of mental activity that allows us to understand the essence of objects, their interconnections, and the regularity of development.

Actually, according to a set of papers (Spytska, 2022; Cottrell et al., 2007; Webster & Ward, 2011; Cantril, 1947; Cheng et al., 2010; Kankaraš, 2017; Snyder, 1983), socially significant characteristics of each human personality can be presented as follows:

- the ability to control biological instincts determines such traits as endurance, courage, will, and work capacity;
- the ability to physically control the body (or its various parts);
- the possibilities of figurative thinking, i.e., the ability to create abstract models of the real world (sense of harmony, spatial vision, aesthetic features, etc.);
- psychological resilience, i.e., the ability to maintain the ability to engage in intellectual activity in different physical and informational conditions;
- the ability to influence others with information, for example, in the form of verbal and logical constructions, etc.;
- the presence or absence of group self-awareness determines moral qualities that ultimately shape the ethics of social relations (patrio-

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tism, sense of duty, altruism, sociability, sensitivity, etc.);

- the ability to perceive, consolidate, and process information (reaction speed, the ability to systematize various types of information, and the ability to analyze and control).

Ultimately, these physiological properties determine the formation of personal characteristics in each individual, which are typically conveyed through categories such as intelligence, character, will, endurance, optimism, emotionality, aesthetic perception, creative skill, talent, pedagogical abilities, patriotism, and the ability to self-sacrifice, among others. The fundamental difference between a person's biological and personal nature is due to the difference in the boundaries of the conditional space in which the potential of these is realized. Material limits always limit the results of the activity of a bio-man and the labor-man, since the biological nature of a person has to function within the strict physical limits of his homeostasis.

The purpose of this study is to examine the roles and functions of humans in the processes of implementing Industry 5 through the analysis of personality transformations in social and labor entities.

2. RESULTS AND DISCUSSION

The emergence of the concept of Industry 5.0 is a response to the potential problems that Industry 4.0 has brought. The most acute of these is the search for the role and place of humanity in a world where self-replicating cyber-physical systems, AI, and robots will hold the leading role in the production system. The key idea that runs through most publications on Industry 5.0 is the need to return humans to the production sphere. The corresponding problem arose because automation within Industry 4.0 renders a significant part of the workforce unnecessary. Using the method of linear extrapolation for predicting trends, the stable and rapid development of automation in production operations is expected for 2025–2023, encompassing both routine administrative and physical tasks, as well as complex technical and analytical processes (Table 1).

The highest automation rates are observed in areas where the use of artificial intelligence, robotics, the Internet of Things, and big data analytics enables significant increases in efficiency, accuracy, and productivity. However, in complex technical tasks and strategic decision-making processes, people continue to play a key role despite the introduction of technology, emphasizing that full automation is not possible in all areas, and a human-centric approach remains the basis of production systems. Industry 5.0 shifts away from the concept of total automation and the replacement of human labor, instead focusing on cooperation between humans and machines. The main principles that connect automation trends with Industry 5.0 are related to four main blocks:

- human-centricity (technology enhances worker well-being by eliminating routine, dangerous, or tiring activities);

- cognitive automation (IoT, blockchain, and AI make systems adaptive and focused on the needs of people and the environment);

Table 1. Forecast of changes in the share of production operations (%) performed in automatic mode

Source: Our estimations based on WEF (2018), Psico-smart Editorial Team (2024), Gencer (2024a, 2024b), Wang et al. (2025), Grznár et al. (2025), VECNA Robotics (2023).

Type of activity	Period			Forecast		
	2018	2023	2024	2025	2026	2030
Preparation and decision-making	19	28	30	32	34	41
Coordination, management, and design	19	29	40	45	50	61
Communication and interaction	23	25	31	34	37	39
Administration	28	44	50	55	60	72
Performing physical work and manual labor	31	44	60	66	72	89
Identifying and evaluating work-related information	29	46	60	65	70	91
Complex and technical activities	34	45	46	47	48	58
Searching for and obtaining the information necessary for work	36	40	55	58	62	74
Information and data processing	47	62	70	75	80	93

- inclusivity and adaptation (communication automation through Chabot creates transparent and integrated business processes for the global economy);

- sustainable development (high automation of physical processes contributes to the efficient use of resources, reducing emissions and waste, which is in line with sustainable development goals).

Thus, automation is the main tool for implementing the concept of Industry 5.0, where technology maximizes economic, environmental, and social development. This creates a new paradigm where technological advances serve humans while maintaining their central role in the system.

The "return" of man to the sphere of production within Industry 5.0 is a symbolic metaphor. Man has never left it completely and will never leave. However, this metaphor has a particular meaning. The man-labor of the industrial era must leave the production, and in its place must come the man-labor of the era of the Internet of Things and cyber-physical systems. The revolutionary nature of Industry 5.0 is determined not only by the change in the structure of individual spheres of production activity, but also by the change in the attitude of the person-producer to their work. Within Industry 5.0, not only the skills (competences) of a person, but their own preferences and desires in choosing the subject of production and production technologies will play an increasingly important role. A similar trend is visible in the development of freelancing, where individuals can choose the desired type of activity and the corresponding types of results of their work, offering them to potential consumers.

Industry 5.0 radically changes the conditions of human activity. People can work while staying in their place of residence, where the creation of comfortable working and leisure conditions is greater than outside. The worker within Industry 5.0 can choose a comfortable work and leisure mode for themselves. Another specific trait of Industry 5.0 is personalization, which involves providing goods or services specifically tailored for an individual. There are two important tools for implementing personalization, which are personification and customization. The first one allows the manufacturer to fulfil the client's order with maximum consideration of their wishes (e.g., size, style, color, and manufacturing details of the clothes ordered by the client will be maintained). The second one (customization) allows modification of a product, and its adaptation to the needs and desires of the consumer can be carried out by the consumer themselves, that is, by a specific client (Davis, 2018). However, the most important aspect of the Industry 5.0 economy is that both the producer and the consumer differ significantly from their counterparts in the pre-industrial and industrial eras. The primary distinguishing feature of future economic systems should be the prioritization of personality development in production and consumption. The future producer would be capable of something that machines equipped with artificial intelligence would probably not be able to do (e.g., work that requires emotions, such as surprise, curiosity, empathy, and ultimately, creativity). The information economy consumer is fundamentally different from the consumer of previous eras. The prominent examples of future production should not be factories with their aisles, workshops, and equipment, but the spheres of information activity: science, education, medicine, art, culture, show business, tourism, sports, recreation, architecture, sociology, and much more.

The most important task for a person in a future production environment is to establish business contacts with artificial intelligence and cyber-physical systems, also known as "cognitive computing" (Rossi, 2018). It should be noted that, changing the production sphere, a person is forced to change himself. In particular, significant changes have occurred in the ten most important skills (Figure 1).

A personality nature is informational and, therefore, has no material limits to its expression. The personality that functions (thinks, feels, acts) within the biological body of a person has an exclusively informational nature in its manifestation, utilizing material biochemical processes occurring in the organism. It can be imagined as an information phantom that consumes and produces only information. However, the individual has to constantly overcome the limitations of the biological body in which it has to exist. Another limita-

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Source: Our estimations based on WEF (2018, 2024), Strategy+Business (2024), PwC (2024), Bevilacqua et al. (2025), Willment et al. (2025), HR Vision (2022).

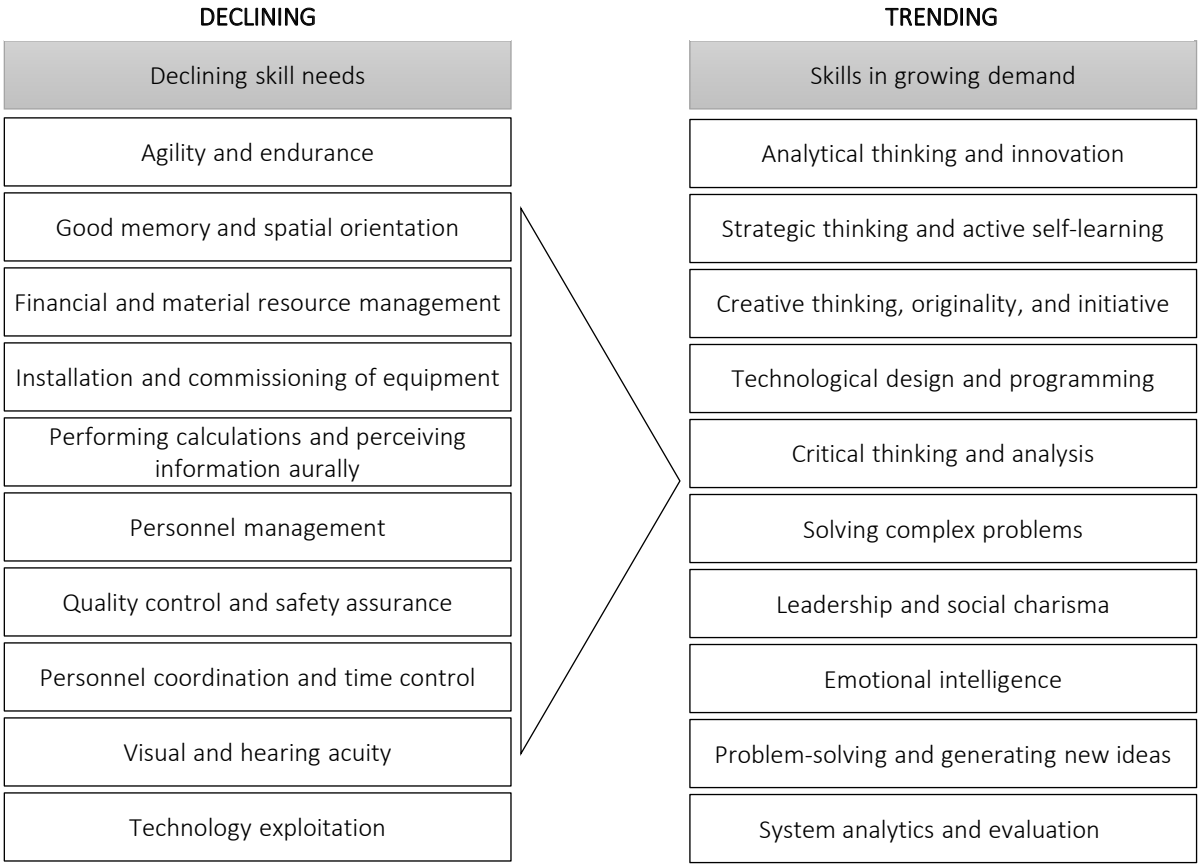

Figure 1. Forecast of the top ten demanded professional skills

tion is the materiality of the means from which it creates its work and the information content, which can reach infinity. Thus, the personality is characterized by the desire to create an infinite informational principle of a human-socio in the limited material body of a human-bio. This is expressed in two key points: first, infinite opportunities to develop (improve) personal traits (for example, the ability to learn about the world around us). Nature is infinitely complex at every point (e.g., multidimensional, multifaceted, and multifaceted), and human art is an attempt to reflect this infinity of nature. However, to create a masterpiece of infinite depth, the artist must possess the infinite information potential of their creative nature. To consider the infinity of nature, infinity is needed – the infinity of its Creator. Ideally, society's social development is realized in personality development, and each person should strive to develop their infinity, but in different ways. The more developed a society is, the more diverse its members are in manifesting their personal properties. The considerations expressed about the essence of personality facilitate a deeper understanding of the context of Industry 5.0, the primary direction of which is personalization. For the consumer, Industry 5.0 presents maximum opportunities to choose the characteristics of the products they consume, while the primary subject of consumption (in terms of time and cost) becomes the materialized information in the products and services used.

To organize a structured discussion of the obtained results, a several-step procedure is performed, which includes identifying relevant publications, assessing their study quality, and summarizing the evidence with the obtained results. Among the databases for structured discussion, the Scopus database was chosen due to the availability of corporate accounts for it. Setting up the keyword as "Industry 5.0", 93,572 documents were found. Adding the key terms "human centric" and "transformations", and limiting the research sphere to "Business, Management and Accounting" and "Economics,

Econometrics and Finance", a total of 72 documents were found. Having concentrated on the latest evidence from 2025 and excluding the book chapters, 17 research papers and documents were identified that fall within the scope of this research.

Thus, the obtained results are in accordance with Cimino et al. (2025), where it was proved that Industry 4.0 achievements significantly influence workplace well-being, based on the estimation of the impact of system quality, experience with technology, and technology use. Chigbu and Makapela (2025) extend the Industry 5.0 approach and add Education and Work 5.0 to underline the human-centric, sustainability-responsible, and AI-included transformations. The main policy recommendations include upgrading national innovation policies, curriculum reforms, and improving work conditions in coherence with the SDGs. Latino (2025) has proposed a tool to estimate the maturity of firms within Industry 5.0, with a focus on SDGs, resilience, and human-centricity in production. The lower the level of technology used, the more room there is for improvements in production to meet sustainability, resilience, and human-centric challenges. Olsson et al. (2025) also underscore the necessity for Industry 5.0 promoters in business to adopt a human-centric perspective by focusing on organizational prerequisites (e.g., a holistic approach, inclusiveness in organizational transformations, new leadership, and innovations). Seelent et al. (2025) combine Digital Transformations and Corporate Social Responsibility with the Industry 5.0 framework, with a specific focus on sustainability, human-centricity, and resilience. It has been proven that Digital Transformations and Corporate Social Responsibility advance the principles of Industry 5.0. Ahmadi et al. (2025), using a systematic literature review, emphasize labor flexibility as a key feature of Industry 5.0, which can accelerate the transformation of modern industries towards resilience, sustainability, and human-centeredness. El Jaouhari et al. (2024) argue that Industry 5.0 presents a possibility for a new manufacturing paradigm where humans and machines complement each other, and production processes are more human-centered and SDGs-oriented. Sharma et al. (2025) also emphasize that within Industry 5.0, human-centric manufacturing, sustainable methodologies, and AI technologies are key areas for research. Ferhataj et al. (2025) demonstrate that better digital literacy among workers is associated with higher optimism about AI's role, while there remains skepticism regarding AI's ability to possess human-centric traits (e.g., creativity and emotional intelligence). Therefore, specific conditions are necessary for human-based workplaces within Industry 5.0. Boschetti et al. (2025) state that, despite the advances of Industry 5.0, there is still a place for human flexibility, dexterity, and judgment, and highlight the necessity of dynamic task usage in AI-human environments to meet human-centric goals. Kober et al. (2025) state that within Industry 4.0, the AI integration improves product consistency, promotes cost reduction, and increases operational efficiency, while Industry 5.0 brings human-centricity and sustainability. Hémono et al. (2025), supporting Industry 5.0 as a human-centric, resilient, and SDGs-oriented approach, draw attention to digital twins as a way of collaboration between humans and robots through the use of predictive models and human-centered techniques. Hansen et al. (2025) state that digital transformations are closely related to workers' competencies (e.g., data handling, integration capability, upskilling and training, and strategic management capabilities).

In general, the above-mentioned discussion is in line with the obtained results that within Industry 5.0, the physiological needs human-bio and the technocratic interests of a labor-human are overwhelmed by the socio-human (personality) needs, and in complex technical tasks and strategic decision-making, humans continue to play a key role, emphasizing that a human-centric approach remains the basis of production systems.

CONCLUSION

The purpose was to examine the roles and functions of humans in the processes of implementing Industry 5.0 through the analysis of personality transformations in social and labor entities. Industry 5.0 appeared as a response of human society to the potential negative consequences of Industry 4.0, following the displacement of humans from the production sphere due to the widespread introduction of

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automated cyber-physical systems. Therefore, within Industry 5.0, the possibility of "returning people to production" arises, enabling human-centricity in economic systems from both production and consumer perspectives. As a result, the role of humans in the economic system is transforming, since new personalities (in terms of social and labor entities) must ensure the synergy of technical capabilities of artificial intelligence/cyber-physical systems, and the potential to humanize the production environment together with the sphere of consumption. In general, personality transformation is a transition from the dominant use of materials and services, dictated by the material nature of the human-bio, to the consumption of mainly information and services, which is determined by the information nature of the human-socio (personality). All the growing power of future technologies must be oriented toward personality development, where the increase in efficiency and productivity is replaced by the priorities of social development of society and its members. Among the main human skills for which demand is decreasing are dexterity and endurance, good memory, financial and material resource management, equipment installation, personnel management, quality control, and technology operation. In contrast, Industry 5.0 requires analytical and creative thinking, the ability to design technology, and critical thinking.

Further research should focus on developing models of harmonious interaction between humans and artificial intelligence, as well as on understanding the roles of values, empathy, and ethical responsibility in the digital industry of the future.

AUTHOR CONTRIBUTIONS

Conceptualization: Leonid Melnyk, Sandor Remsei, Oleksandr Kubatko.
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