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Human Capital Development in the Context of the Fourth Industrial Revolution

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Abstract. In the context of the fourth industrial revolution, high-quality human capital that creates innovations is becoming the key factor in building the competitiveness of individual companies and the national economy as a whole. The digital transformation of public life has had a significant impact on human capital development. Remote communication, robotics and artificial intelligence technologies have created new opportunities in education, health care and employment. Education and health care have become more individualized and high-tech. Opportunities for remote employment and combining work in several companies have appeared. However, digitization also poses challenges and threats to human capital development. These include the need for continuous upgrading of competencies, increased levels of stress due to the increasing information and emotional load on an individual operating in the digital environment. The general job cuts and decline in the rights of employees who have switched to telecommuting also characterize digital economy. In addition, the introduction of digital tools increases the risks of discrimination against various population groups and growing social and economic inequality. Under these conditions, holders of human capital face the need to acquire new knowledge, improve their professional qualifications and comprehensive personal development throughout their lives. In order to ensure the least painful inclusion of all society members in the digital environment, the state and business must create conditions for increasing the level of digital, financial and legal competence of population.

1. Introduction

Human civilization progressive development is carried out through two closely interconnected processes - deepening of labour division and progressive advance of science and technology.

Scientific and technological progress tends to evolve through the development and improvement of existing scientific discoveries. At the same time, the smooth and orderly development of scientific knowledge and technological developments is occasionally disrupted by breakthroughs fundamentally different from earlier ideas. These discoveries are the backbone of revolution in technology and engineering used in a wide variety of areas of public life.

In all, four industrial revolutions have been singled out in the economic history of mankind. The invention of the steam engine in the second half of the 18th century and its large-scale introduction in industrial production and transport marked the transition from manual to machine production, which became known as the first industrial revolution. The arrival of electrical energy marked the beginning



of the second industrial revolution of 1870-1914, the main inventions of which were the electric lamp, phonograph, internal combustion engine and assembly line production.

The third industrial revolution took place in the 1980s as a result of the massive spread of digital technology. Personal computers, the Internet, automation and robotics of technological processes that were developed at that period of time formed the basis for the next stage of scientific and technological progress - the fourth industrial revolution [20]. The 4.0 industry is based on artificial intelligence, the Internet of Things, wireless communication and robotics technologies that allow for the effective implementation of the concepts such as Intelligent Factory, Smart Supply Chain, Smart City. The current stage of digitalization is fundamentally different from the previous technological breakthroughs in the depth and scale of transformation processes that lead to the blurring out the differences between physical, digital and biological spheres of human life [21].

Today's economic and social realities define the growing importance and new features of the use of human capital, as well as the higher and ever-changing demands for its maintenance. The widespread introduction of digital technologies imposes new requirements for creativity, self-control and critical thinking of individuals that are forced to operate in an increasingly uncertain environment [14]. Lifelong learning should become an absolute imperative for every professional who wishes to remain competitive in the context of digitalization [17].

We can say that we have come to the need for the permanent human capital formation. The rapidly changing principles the workplace organizing from clear delimitation of duties to project work challenge the previously high value of work experience. The determinants of education and new competencies are becoming central to the question of the efficiency of investment in human capital [12]. According to empirical studies, the highest priority when choosing a location for information and communication companies is the availability of the required number of highly qualified professionals, which emphasizes the high importance of human capital in the modern economy [18]. There are also a number of trends in the use of human capital in Industry 4.0 in the scientific community, which include a general cut in the number of jobs, the overflow of specialists in the industry with the highest added value, and an increase in the demand for job seekers with the necessary skills to work in the digital environment [22].

2. Problem statement

The Fourth Industrial Revolution enhances the economic efficiency of business, the quality of public administration and the comfort in everyday life. These positive effects are due to the automation and robotics of production, wireless communication, and the introduction of artificial intelligence technologies that constantly strive to optimize, and that are devoid of inherent errors and limitations. This raises the question of the role and characteristics of human capital development in the new digital reality.

This publication is a theoretical paper based on the analysis and structuring of conceptual studies on the impact of the digital transformation of the society on the formation and human capital use. In accordance with the systematic approach aimed at studying the trends in the field of education, health care and population employment, the study and understanding of the processes that change the requirements for human capital and have both destructive and positive effects on its development, have been carried out.

3. Research findings

The comprehension of the concept of «human capital» underwent changes in the same way as the peculiarities of its formation and use in the economic life of the society changed. The theory of human capital, which appeared in the 1960s, understood it as an individual's accumulated store of knowledge, abilities, skills, health and motivations. Within the framework of this theory, each person was viewed as an investor, weighing the marginal rate of return on investments in their education and medical care with the return on alternative investments. In recent decades, the understanding of human capital in the economic literature has become much broader. The image of a rational egoist who invests resources in

himself in order to maximize income, has been replaced by a person for whom both work and leisure, political and cultural events are important [8].

Besides, in the sphere of education, the concepts of «knowledge», and «skills» have been replaced by the concept of «competence». The latter are more focused on practical results in working life and also include personal qualities relevant to the occupational sphere. The digital economy, based on the rapid development of knowledge and creative use of knowledge, determines the exclusive role of high-quality human capital in economic progress. The paradigm for the economic success of any company in the modern world is the retention of leadership in the rivalry of innovation [1]. Key competencies formation necessary for the development and introduction of innovative products and technologies is the basis for the competitiveness of individuals, enterprises and the national economy as a whole.

The digital transformation of various aspects of human existence has had a significant impact on human capital formation. Information transparency promotes the development of humanistic values in society, the efficient operation of social lifts, the development of creativity and the acquisition of additional knowledge [14]. The use of information technology has increased the intensity of the learning process and made it more interesting and accessible. Artificial intelligence technologies will enhance the individualization of educational process according to the personal characteristics of each student [10]. Mass online courses serve as an additional learning opportunity for students and a marketing strategy for expanding the market for resource-endowed universities [15]. Digital hubs promote personal skills and knowledge, digital literacy, e-commerce and business mentoring, thus providing a powerful tool for rural community and business development in Europe [9].

High level of integration of individuals into social networks makes it possible to predict the possibility of depression and reduces death risks from cardiovascular diseases, drug overdose and suicide [7]. Social networks and Internet forums are convenient platforms where health professionals or people with rare and chronic diseases can share knowledge and experience. Online interaction between health-care organizations and patients improves the comfort and quality of the services provided. Internet traffic and mobile data monitoring with the help of artificial intelligence can improve the prediction of infectious diseases outbreaks [19].

However, digitalization does not only create new opportunities and enhances human capital quality, but also makes negative effects in education and health care. For teachers, the digitization of the educational environment is accompanied by an increase in the workload and the displacement of experienced teachers who do not have the required level of digital competence. For students, the increasing distortion of information in the process of its transmission, informational overload, simplification of interpersonal communication and, as a consequence, difficulties in the formation of the corresponding competencies are topical. A significant risk of digitalization in educational sphere is a decrease in the level of students training who lose the need to memorize information available online [10]. The possibility of the global education market control by a few large companies providing software and information platforms for the educational process, arouses concern [15].

The search inquiries of each user form around them an information cocoon that narrows the horizon and presents a simplified view of the reality [14]. Cyber-attacks on medical systems for extortion endanger patients' personal data. The collection of information by media companies about user searches and purchases can lead to violations of privacy, including health issues. In some cases, this can cause serious harm to a person. For example, if data on the diseases of an applicant for a prestigious position or information about pregnancy hidden by a woman gets into the public domain. Fake news and misinformation spread over the Internet can form irrational patterns of behaviour, such as self-medicating or anti-vaccine beliefs [19]. The fourth industrial revolution brought about significant changes in the use of human capital. Information technology overcomes territorial and time barriers, creating an opportunity for flexible and non-standard forms of employment carried out remotely. Thanks to digitalization tools, young people, women with children and people with disabilities, who were considered the most vulnerable categories of the population, can increase their competitiveness and get new opportunities in the labour market. Using the examples of Ghana, Kenya

and Uganda, it is proved that increasing the availability of smart phones, mobile Internet and electronic payments systems development create new mechanisms for generating income for young and go-ahead African women [5]. In the labour market, there is an increasing demand for professions that form and serve the digital environment, as well as for specialists with the competencies necessary to work with digital tools.

At the same time, the scientific literature also notes some negative aspects of the impact of digitalization on human capital functioning. Vulnerabilities arising in cyberspace and dependence on digital technologies lead to the formation of an uncertain institutional landscape and the adoption of destructive decisions that block cooperation, which reduces the effectiveness of human potential use [13]. In addition, there is a problem of human compatibility and information and communication technologies. It is noted that the introduction of digital technologies at nuclear power plants can negatively affect the cognitive reliability of operators due to the peculiarities of interface management, excessive trust in automation and the complexity of information systems [24]. Automation and robotization reduce the demand for low-skilled labour for routine operations. Medium-skilled employees will also be exposed to the process of labour release as a result of artificial intelligence technologies introduction. Specialists with higher education are faced with the need to constantly improve their competencies, because otherwise they will also join the ranks of the unemployed [20]. The introduction of distance technologies into the economic system increases the risks of precarious and insecure employment for workers. Distance working contributes to the transition from open-term employment contracts to fixed-term employment contracts and civil contracts for work or services. This deprives workers of guaranteed rights to normalized employment, regular wages, a safe working environment creation, social insurance and holidays.

Individualization of employment does not only confront a man of today with the need to master professional competencies, but also requires them to be able to analyze the situation in the labour market, negotiate, understand the legislation, and independently organize his working environment and time [23].

Paradoxically, the introduction the fourth industrial revolution innovations in the economic and social spheres is often associated with growing risks of discrimination and growing inequality between different social groups. One of the reasons for this is the digital barrier or digital divide - unequal access for various categories of the population to information resources, information technologies and technical means due to economic, physical and competence-based limitations [6]. It is noted that the digital barrier will increase the labour market segmentation and the income gap between specialists of different skill levels. The trend of job cuts will also seriously affect the interests of developing countries, to which developed countries have previously moved production capacity. Rising unemployment will worsen the social and political situation in developing countries, increase migration pressure on wealthy neighbours, and bring more international tensions [20].

Digitalization can also cause an increase in discrimination in the society. A case is described when a computer programmed to learn a language by processing a large data array began to operate with stereotypes drawn from the studied texts. The automatic face recognition system makes more mistakes when dealing with dark-skinned people, which increases the likelihood of false accusations and arrest.

Using targeted advertising tools some powerful persons can manipulate the results of user inquiries in search systems, and limit the important information receiving for certain social groups [19]. Collecting and analyzing big data carries the risks of creating individual social ratings and clustering the population, which will exacerbate the problems of social differentiation, marginalization and unequal access to existing opportunities and benefits in the society [14].

Realization of discrimination risks and social inequality growth will mean depriving any part of the population of opportunities to develop and use their potential. This will have a negative impact on human capital formation and use not only for socially disadvantaged groups. Personal and professional development motivation of the rest of the society members who find themselves in the conditions of the social competition level decline will drop.

In Russian economic science, problems that hinder the development of highly qualified human capital are noted. These include weak influence of human capital on the national economy development rate, as well as the lack of an unambiguous relationship between the value of individual human capital and wages. The latter explains the lack of interest in improving the qualifications of working Russian people and the fact that the value of education of the surveyed respondents has no clear connection with labour values. Higher education is more likely as to follow a social norm [16].

The reasons for this situation in the literature are called the differentiation of country's territories by the level of social and economic development, deformation of the economy structure and insufficient demand for human capital [8]. Regional differences in the level of social and economic development determine the fact that the return on human capital directly depends on the place of residence of the employee. Despite the same level of qualifications, wages of factory and office workers in megalopolises are more than two times higher than those of their colleagues working in rural areas [3]. The deformation of the Russian economy structure is manifested in its export and raw materials orientation. As the holders of the best quality human capital want the maximum return on investment in education, they seek higher-income sectors. In the context of the existing Russian economy model, these industries are low-tech extractive industries. As a result, the most competent specialists settle in unproductive sectors of the economy and are engaged in rent seeking instead of producing it [8]. The large shortfall in demand for quality human capital compared to supply is due to the low-technology structure of the Russian economy, lack of ownership security, the lack of investment resources for companies and the development of the shadow sector of the economy where, as a rule, only basic competencies are required [11]. One can be optimistic that the Fourth Industrial Revolution will be able to remove the obstacles to human capital development in Russia. The use of artificial intelligence, the Internet of Things, additive technologies, big data, distributed ledger systems, quantum technologies, virtual and augmented reality, wireless communications and robotics will significantly increase labour productivity and ensure the development of industries that create high added value.

There will be an increase in the income of Russian companies, an increase in the revenue share of the budget due to tax revenues increase and a corresponding increase in living standard of the population. In the long run, this will be able to minimise, and then completely solve the problems hindering high-quality human capital development in Russia. However, taking into account the experience of developed countries, there is a need for systematic government support for digital transformation in the form of an enabling institutional environment and sufficient public investment [25].

Let us now turn to the main measures aimed at building the human capital needed in the current digital phase. First of all, let us note the discrepancy between the content of educational programs implemented by educational institutions and the expectations of employers regarding graduates [2]. Thus, there is an urgent need to adapt the curricula of the various levels of the educational system to the evolving needs of the market. It should be borne in mind that the main beneficiaries of the fourth industrial revolution will be the holders of the highest qualifications of human capital [20].

The information channels used by young people must be filled with high-quality educational content in order to provide the new generations with systematic professional, human and digital knowledge [23]. It is possible to increase the educational component of human capital effectiveness by means of the resourcing corresponding to the universal digitalization goals, digital tools popularization, training system modernization and motivation of teachers, as well as changes in the criteria and mechanisms of the educational process control [10]. Educational clusters can generate the necessary competencies for learners [1]. Employers' representatives should be involved in the educational process. Telecommunications infrastructure within and between educational institutions should be developed, and international cooperation in the form of advanced training of teaching staff abroad and exchanges of personnel should be strengthened [4]. In terms of defining the competencies needed to build modern competitive human capital, most researchers agree on what they call professional, socio-behavioural and technical (digital) competences. This combination will make it

possible to effectively do professional tasks, carry out interpersonal communications leading to success in different spheres of life and live comfortably in digital society [12; 22; 23].

In addition, cognitive, financial and entrepreneurial competencies are mentioned in the literature [12; 22]. It has also been noted that changes in the professional environment and career progression are changing the necessary set of competencies for a particular holder of human capital [23]. The rapid transition to digital economy requires that governments and companies increase the cost of retraining. Another important challenge facing the state is fair distribution of benefits from digital transformation [17]. The uncertainties and security threats in cyberspace require governments to make institutional conditions in order to create an atmosphere of trust among the subjects of digital reality [13]. The dilemma between free information exchange for the development and enrichment of knowledge and access restriction to the information within the framework of the intellectual property protection should be resolved based on the interests of human capital development. Free access to knowledge should be organized by educational and research institutions, national small business [1].

4. Conclusions

The driver of economic development and the measure of success at the level of the individual company and the national economy in the context of the fourth industrial revolution is becoming a leader in the flow of widely created innovations. Human capital, as the holder of knowledge and creativity, is becoming a key factor in the creation of competitive innovations. The regular increase in the complexity of the tasks assigned to modern professionals requires them to constantly improve their competencies.

Digital transformation has demonstrated that the same tools of digital economy can have both positive and destructive effects on human capital formation. The positive impact is associated with the expansion of an individual's opportunities in the field of e-learning and remote medical care, with an increase in the level of individualization of services provided and the emergence of new social lifts. The negative impact can be characterized by the stress level increase due to informational and emotional load growth on the individual, a decrease in motivation to acquire knowledge that is available online, simplification and ideas primitivization about reality, and the possibility of monopolizing the global education market.

The fourth industrial revolution also determines the specifics of the human capital use. Many social groups, previously considered the least protected in the labour market, gain new opportunities through distance employment. There is a growing demand for professionals who create and service the digital environment, as well as for workers who have successfully mastered digital tools.

The flip side of the coin in the employment digitalization is general jobs cut due to automation and robotics of the production. There is a decrease in the rights of employees as a result of employers' repudiation of open-term employment contracts when specialists switch to distance employment. It is noted that working in complete uncertainty and cyberspace associated with digital threats is accompanied by the risk of making destructive decisions. The introduction of digital tools also increases the risks of discrimination and growing social and economic inequality. The difficulties that hinder the highly qualified human capital development in Russia are noted. These include weak influence of human capital on the economic growth rate, as well as the lack of an unambiguous relationship between the value of individual human capital and wages. The introduction of the fourth industrial revolution technologies should solve these problems, increase innovative activity of enterprises and income of specialists. However, this will only happen if state support for digitization is provided in the form of an enabling legal and regulatory framework and necessary public investment.

The change in educational programs in accordance with the trends of digital development of the economy, the formation of educational clusters and the intensification of international academic mobility are determined by the key areas of the human capital efficiency increasing at the present stage of digitalization. Modern digital tools must be actively introduced into education, healthcare and everyday life. Digital transformation also requires human capital holders to have not only professional, but also cognitive, social and behavioural, digital, financial and legal competencies. For this reason,

the acquisition of new knowledge, upgrading of skills and personal development become a permanent necessity for every individual to be competitive in modern conditions.

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