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DEVELOPMENT OF THE ELECTRONIC INDUSTRY IN THE CONTEXT OF THE DIGITAL ECONOMY

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Abstract

At the moment, there is a transition to a digital economy, which is characterized by the penetration of digital technologies into various spheres of human activity. Significant changes are taking place in industry. Successful in the global and domestic markets are those companies that change in accordance with the requirements of the market (global competitiveness, efficiency and high labor productivity). “The digital development model involves not only a total digital transformation of the economy into a digital economy and high-tech industry into a digital industry, but also taking into account the triad of requirements of modern global markets associated with a reduction in decision time (Time-to-Decision, T2D), a significant reduction in the execution time / implementation of projects (Time-toExecution, T2E) and a significant reduction in the time to bring products to market (Time-to-Market, T2M), where the market, of course, means the global market. This research provides insights into the requirements of modern global markets and the necessary changes that companies need to make to stay competitive in the global market.

Keywords: Digital economy, digital ecosystem, digital transformation, digital industry, global competitiveness

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1. Introduction

Merging the real and virtual worlds is one of the most significant technological trends today. The technical and operational characteristics of many high-tech products are no longer limited to design and technological innovations, but are improved to a greater extent thanks to the accompanying software, which makes it possible to reduce risks and costs, as well as to predict the operation of products (Elbuzdukaeva et al., 2019). The same can be said about production processes - high-tech equipment can no longer be imagined separately from the accompanying software and digital technologies used at all stages of product creation. The merging of the real and virtual worlds marks the beginning of the fourth industrial revolution, which will be characterized by the transition from so-called embedded systems to cyber-physical systems (CPS) (Zhukova & Kazantseva, 2021). The concept of cyber-physical systems is inextricably linked with the technologies of the industrial Internet and the implementation of “machine-to-machine communication” (M2M), which allow machines to “communicate” with each other and make independent decisions about the mode of operation, quickly and flexibly responding to changing external conditions. With regard to industry, the connection of the virtual and physical world through cyber-physical systems means the emergence of “smart” factories, the characteristics of which are adaptability, self-tuning, flexibility, resource intensity, etc. The fourth industrial revolution was the main theme of the 46th World Economic Forum in Davos (Ovchinnikova & Lavnov, 2019). In his speech, the founder and president of the forum, K. Schwab, emphasized that, in relation to cyber-physical systems, it is necessary to talk about the fusion of technologies and the blurring of the boundaries not only of the physical and digital world, but also of the biological one, and the speed, scope and systemic impact of the occurring phenomena are as follows, that the allocation of the fourth industrial revolution, and not the continuation of the third, is beyond doubt. In terms of technology, the Swiss economist pointed to breakthroughs in the widespread dissemination of digital technologies, as well as artificial intelligence, unmanned vehicles and aircraft, the Internet of Things, 3D printing, nanotechnology, robotics, biotechnology, materials science, energy storage systems, quantum computing (Barzaeva & Ilyasov, 2022; Ilyasov, 2018; Makarova, 2021). However, in an effort to meet the conditions of the new technological paradigm, enterprises face a number of challenges. The steady increase in the requirements for the technical and operational characteristics of the final product stimulates the demand for multifunctional engineering products and necessitates constant modifications of products (products / structures / various technical systems). The complexity of products increases, among other things, due to the increasing number and variety of components (Bignell et al., 2016). According to a study by the Aberdeen Group, which involved more than 200 organizations, the complication of manufactured products is an urgent problem for 33% of respondents. Among representatives of medium and small businesses, this percentage is even higher - 37%. The respondents also identified such problems as changes in design requirements (23 and 25%, respectively), waiting times for decisions / information (23 and 19%, respectively), a large number of technical changes (18 and 16%, respectively). It is noteworthy that for medium and small enterprises, such problems as the waiting time for decisions / information and the number of changes made to the product are less acute (Bignell et al., 2016). The complication of the final product also causes an increase in the complexity of the technological processes necessary for its manufacture (Darsih et al., 2015).

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Moreover, in many dynamically developing high-tech industries, the timely renewal and improvement of production technologies is no less important factor in competitiveness than the improvement of the final product itself (Seifert et al., 2011). According to a study by A. T. Kearney, German enterprises could save $30 billion annually by reducing the complexity of production, while their operating profit could be 3-5% higher (Lin & Li, 2000). Along with meeting the quality and performance requirements of the final product, manufacturing companies are forced to bring products to market faster and faster to remain competitive. 61% of the respondents who took part in the mentioned study of the Aberdeen Group company indicate the reduction of the time to market (Time-to-Market) as one of the most acute problems of the product development process (Bignell et al., 2016). At the moment, up to 80% of the time that the process of bringing a product to market takes is wasted, leading to a decrease in profits and loss of market share (Vorontsova et al., 2019). However, time-to-market is not the only problem that is based on the time factor: it is the final link in the triad of time management issues in the company:

i. reduction of decision-making time (Time-toDecision, T2D);

ii. reduction of execution time (Time-toExecution, T2E);

iii. reducing the time to bring high-tech products to market (Time-to-Market, T2M).

Thus, the total amount of time that the process of bringing a product to the market takes is also affected by the speed of manufacture (the duration of production cycles, the speed of technological operations), and the time it takes to resolve organizational issues and coordinate the activities of various departments (Kaishev, 2013). It is important that in addition to the requirements for the quality of the final product, the requirements for its customization, the maximum “adjustment” of parameters to the requirements of a particular customer, are also growing. Products are becoming more and more diverse, which creates a demand for small series. When using traditional production technologies, small-scale production is disadvantageous for customers, as it means an increase in time and cost. However, with all this, the final product at the same time must have an affordable price in order to meet the requirements of the market.

2. Problem Statement

An analysis of the relationship between indicators of resource efficiency in industry showed the presence of a medium-high relationship between such indicators as: - the level of innovative activity of industrial enterprises and the increase in high-performance jobs - the linear correlation coefficient was 0.6; the coefficient of renewal of fixed assets and the increase in high-performance jobs - 0.5; labor productivity index and increase in high-performance jobs – 0.4; labor productivity index and the level of innovative activity of industrial enterprises - 0.4. The relationship between other indicators of resource efficiency in the industry was insignificant (Bignell et al., 2016). It draws attention to the fact that all statistically significant correlations are positive, which indicates their direct mutual influence on each other. In addition, the analysis made it possible to establish a high correlation between the growth of highly productive jobs and most of the other considered resource efficiency indicators, which once again

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indicates the importance and importance of the effective use of labor potential in the development of resource-efficient industrial production.

Thus, the analysis of the resource efficiency indicators of the Russian industry showed growth in the medium term for most indicators. In addition, there is a medium-high relationship for most resource efficiency indicators, mainly with an increase in high-performance jobs, which indicates a high contribution of labor potential to the development of a resource-efficient industry.

3. Research Questions

As noted earlier, one of the indicators of resource efficiency in the digital economy is the use of labor potential by modern industrial enterprises, since not only the efficiency of digital transformation of production, but also individual technological stages of production, as well as the entire value chain of industrial products depends on the quality of the workforce. Thus, the analysis of labor productivity in the Russian economy showed its unstable dynamics. The index of labor productivity varied from the maximum value in 2012 - 103.8% to the minimum value characterizing its decline in 2019- 98.7%, amounting to 102.9% in 2020 (according to preliminary estimates). Among industrial types of economic activity, the most average value of the labor productivity index was noted in the manufacturing sector, which amounted to 102.9% in 2012-2020, which is higher than the average for the Russian economy - 101.7%; in the extractive industry, the average value of the indicator reached 101.2%, in the electric power industry - 100.6%, in water supply - 100.2% (Kaishev, 2013). The dynamics of changes in the labor productivity index correlates with the dynamics of the growth of high-performance jobs. Thus, the largest decrease in the growth rate of high-performance jobs in the Russian economy was observed in 2019, which amounted to 91.9% compared to 2014, which in absolute terms amounted to 1,671.9 thousand high-performance jobs. At the end of 2020, the increase in high-performance jobs amounted to 1213.8 thousand units, or 105.9% compared to 2019 (Darsih et al., 2015). On average, for 2012-2020, the increase in high-performance jobs in industrial production amounted to 103%, of which 104.1% was provided by energy industry and water supply; 103.2% - manufacturing industry; 101.2% - extractive industry. In general, at the end of 2020, there were 6,623.5 thousand highly productive jobs in the industrial sector of the economy (955 thousand in mining, 4,483.7 thousand in manufacturing, and 1,185 thousand in electricity and water supply), which is 30.2% of the number of highly productive jobs in the Russian economy as a whole. In the digital economy, one of the indicators of industrial efficiency is the production of high-tech and knowledge-intensive products (Seifert et al., 2011). In general, the Russian economy shows a steady growth trend in high-tech and science-intensive products in terms of GDP, which increased from 20.2% in 2012 to 23.4% in 2020.

4. Purpose of the Study

Of no small importance for ensuring the resource efficiency of production is the degree of renewal of fixed assets, which consists in the introduction of more modern, digital equipment, which is characterized by high performance, safety and environmental friendliness. Among industrial types of economic activity, the highest average value of the coefficient of renewal of fixed assets for the period

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2012-2020 was noted in the extractive industry - 7.4%, followed by manufacturing - 6.1%, electricity and water supply - 4.9%. It should be noted that the value of this indicator for all industrial types of economic activity was higher than the average for the Russian economy - 4.5% (Lin & Li, 2000). In the digital economy, as mentioned earlier, the development of industrial production is based on innovation. The level of innovative activity of the Russian economy only in 2011-2013, as well as in 2018 and 2020, exceeded the level of 10%, in other periods it did not reach the 10% level (Vorontsova et al., 2019). The highest level of innovative activity of industrial enterprises in 2012-2020 was observed in manufacturing, which averaged 16.4% (among the types of economic activity of which the leaders in this indicator were enterprises producing computers, electrical equipment, machinery, vehicles, medicines, oil products and chemical production), mining - 7.3%, power and water supply - 5.3%. Thus, in the digital economy, the organization of resource efficiency of industry consists in using a systematic approach to managing the digital transformation of production processes, building new business models and corporate governance systems, introducing innovations that contribute to the creation of sustainable digital ecosystems that increase resource productivity in the value chain (Podkolzina & Taranova et al., 2021).

5. Research Methods

The main directions of digitalization of an industrial enterprise in order to increase its resource efficiency based on internal innovations can be the following:

1. Monitoring the state of equipment and industrial infrastructure facilities. 2. Accounting for operating time and equipment downtime. 3. Calculation of the cost of the life cycle of equipment; formation of requests for the supply, accounting and write-off of spare parts; maintenance and repair management. 4. Accounting for energy consumption, automated control of air conditioning systems. 5. Monitoring of technological process parameters, online notifications about the completion of process stages, parameter deviations. 6. Automated control systems (ACS) for the most individual technical processes and technological chains. 7. 3D modeling of production sites, transition to 3D design. 8. Digital exchange platform between participants in the value chain without intermediaries, reducing all kinds of production and management costs. The creation of a sustainable digital ecosystem of an industrial enterprise is based on such system components focused on process and organizational innovations that increase resource efficiency, such as: Research & Development: constant search and testing of new technologies and solutions, their study, launch of pilot projects, preparation of information for management decision making (AR/VR, IOT, Machine learning, Machine Vision, Process Mining, RPA, etc.); electronic document management: transition to full electronic interaction in the internal and external circuit. The external circuit involves the exchange of contractual and primary documents with suppliers and buyers; internal contour - interaction of all structural divisions of the enterprise in electronic form (electronic document, electronic digital signature); digital project committee: development of a corporate project management system according to the PMBOK methodology; accounting for the life cycle of the project from initiative to closure; accounting of all project documents, including protocols of the project committee; monitoring of project implementation in terms of key indicators of terms, investments and quality; EAM and mobile repairs: improving the efficiency of production asset management, applying modern methods of equipment life cycle management, methods for analyzing the current state of

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equipment, risks and production losses from equipment failures to determine optimal strategies for maintenance and repair (MRO), optimization of MRO processes, forecasting residual resource of the equipment; electronic mobile bypasses (Seifert et al., 2011): NFC technology improves the quality of the bypass, reducing the risk of unscheduled shutdown due to early detection and elimination of the defect; 3D scanner, 3D printer, 3D design, computer numerical control (CNC) machines: 3D systems are aimed at reducing the cycle from design to manufacturing a rare spare part or project as a whole; reduction of design errors; CNC machines increase the accuracy of the product and the speed of production; digital laboratory (Lin & Li, 2000): the system is designed to manage laboratory workflows and documents; optimizes the collection, analysis, return and reporting of laboratory data; integration and transfer of data to visualization systems helps operational personnel manage production; digital twin: a complete production model that allows determining production losses, optimizing technological regimes and consumption rates, as well as testing solutions aimed at improving the operational efficiency of existing technological processes and production in general; visual management of production efficiency: keeping the technological process close to the reference values; automatic calculation of losses in production with visualization of deviations; visualization of PowerBI indicators (Vorontsova et al., 2019): stained-glass windows and dashboards of indicators with advanced visualization tools that facilitate the interpretation of data for managers and specialists, for a prompt and balanced decision; BPMS: support for the process approach; evaluation of the effectiveness of all key processes of the KPI process; process monitoring, in order to find losses, eliminate them and stabilize them; digital economy: a planning system and a plan for factor analysis of all enterprise budgets; reducing the time for summing up and corrective actions, etc. Let us summarize the main principles of the methodology for organizing the resource efficiency of industry based on innovations in the digital economy (Klishina et al., 2017). Undoubtedly, the key principle of this methodology will be the competence of the personnel responsible for the implementation of innovations, digital solutions in the field of resource conservation. In the digital economy, the following competencies are most in demand: adaptability and flexibility; technical savvy; creativity and innovation; data literacy; critical thinking; digital and coding skills; leadership; emotional intellect; the need for constant learning. The next principle of the methodology for organizing the resource efficiency of industry should be called transdisciplinarity, which involves the use of approaches that have given positive results in one area to another subject area (Taranova et al., 2021). The principle of multidisciplinarity, which consists in combining tools, methods and models of management of various fields of activity. The principle of cross-disciplinarity, which involves the study of one subject area from the perspective of another in order to identify new ways and mechanisms to eliminate bottlenecks. The principle of innovation based on the use of collaborative innovations resulting from jointly implemented innovations between partners in the value chain.

5.1. Digital transformation of telemedicine services

The COVID-19 pandemic has become a catalyst for such important areas of digital transformation of the Russian healthcare system as the transition of medical organizations to legally significant electronic document management, the introduction of specialized information systems in medical organizations, the development of electronic services and services, and telemedicine. Successful introduction of new digital

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technologies in the industry requires improving the digital literacy of medical personnel, providing them with electronic signatures and the necessary equipment, including high-tech ones (Vorontsova et al., 2019). It is required to develop and implement effective cybersecurity solutions, including those based on distributed registry technologies, which will ensure a high level of security of medical data during their collection, storage and transmission (Klishina et al., 2017; Podkolzina & Belousov et al., 2021). In order to expand the possibilities of using telemedicine technologies, it is necessary to improve the regulatory legal framework, including the mechanisms for setting tariffs for the provision of telemedicine services in the system of compulsory health insurance (Taranova et al., 2021). For the convenience of patients, it is necessary to develop digital services that allow you to receive the necessary medical documents (certificates, extracts, prescriptions) in electronic form without a face-to-face contact with medical organizations, as well as manage your medical documents. Digital services should allow you to quickly make an appointment with the right doctor, get information about his education and work experience, available medical care, for example, using a digital assistant based on intelligent chatbots. The development of personalized medicine will require the creation of digital medical profiles for citizens, which will also display data from wearable devices for remote health monitoring (Shmatko et al., 2016). Patients with chronic diseases will be able to be under constant medical supervision without having to go to the hospital.

5.2. Promising methods and technologies in AI

The increasing complexity and volume of data generated and used in healthcare creates ample opportunities for the use of AI technologies. Patients and healthcare providers, as well as companies specializing in the life sciences, are already using several classes of AI systems today: diagnostic and treatment recommender systems, patient status and lifestyle monitoring systems, administrative process support systems, as well as a variety of auxiliary systems. providing diagnostics of individual nosologies (Sugaipova & Gapurov, 2018). At the same time, although today AI systems can perform tasks in the field of healthcare as well as people, regulatory and organizational barriers will not allow significant automation of the work of medical institutions for a significant period. However, the development of new AI technologies will penetrate deeper into the field of healthcare, affecting, among other things, the ethical issues of their use.

6. Findings

In healthcare, only pilot projects are being implemented using distributed ledger technologies. The medical industry is one of the most regulated and conservative, the introduction of new technology requires serious financial investments, new products are introduced much more carefully and more slowly than, for example, in the financial sector. In order for clinics to be able to exchange patient data even within the same country, it is necessary not only to create a common network, but also to ensure a much higher level of information security in medical institutions. All this significantly affects the timing of the implementation of developments in the industry. One of the promising niches for using the technology is the storage of electronic patient records in Russian medical institutions.

7. Conclusion

Thus, we note that digital transformation is changing the face of the economy and is the basis for high rates of economic growth. Now Russia is noticeably behind many developed countries in terms of the pace of digital transformation of industry. At the same time, Russia has great opportunities to become a leader, relying on the existing technological and intellectual potential. It can be concluded that one of the main reasons for the backlog is the lack of investment resources; regulatory framework that does not meet modern requirements; "digital divide"; shortage of qualified personnel, etc. Improving the state investment policy aimed at raising funds for the modernization of industrial equipment and automation of business processes would allow the Russian industry to reduce the technological gap. It is also necessary to create a favorable regulatory environment: the legislative foundations of the digital economy and the system of legal regulation of the institutions of the digital economy. In addition, it is necessary to increase the amount of public funding for R&D in the field of digital industrial technologies and provide assistance in testing and implementing innovative developments.

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