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Global Challenges and Prospects of the Modern Economic Development

DIGITAL TRANSFORMATION OF RUSSIAN MECHANICAL ENGINEERING

A. B. Vishnyakova (a)*, L. G. Nabieva (b), A. R. Fatkhullin (c)
*Corresponding author

(a) Samara State University of Economics, Soviet Army Str., 141, Samara, Russia, angelina8105@yandex.ru
(b) Kazan (Volga Region) Federal University, Butlerova Str., 4, Kazan, Russia, larisa-nabieva@yandex.ru
(c) Kazan (Volga Region) Federal University, Kremlyovskaya Str., 18, Kazan, Russia, 2361646@mail.ru

Abstract

The most important factors of economic growth are digitalization, the economy structure transformation, and the activation of technological development of industrial production. The application of digital technologies in industries contributes to an increase in labor productivity, import substitution. That is especially important in the current economic conditions, in the context of sanctions and limited access to imported equipment. Under conditions of active digitalization of the economy, more and more attention is focused on the modernization of leading industries (especially domestic mechanical engineering). A single information space is being created to build effective interaction mechanisms between economic entities. In the 21st century, society has embarked on a path of transformation, which means that it needs innovative solutions in the economic, social and political spheres. But despite the global changes in the economy, modernization in the national economic system of different countries takes place in its own way. For example, in Russia, the transformation path from a planned to a market economy has lasted for 30 years. Changes in the systems of the Russian economic life are taken from the experience of developed countries. The transformation of enterprises has a number of specific features: it lends itself to spontaneous factors; insufficient management leading to unpredictable results, the most serious of which is the crisis, loss of scientific, technical and production potential, an increase in the share of imported goods over domestic ones. These features give rise to dependence on developed countries that have become serious competitors.

Keywords: Digital economy, digital modernization, globalization, industrial production, modernization of industrial enterprises

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1. Introduction

One of the problems of slow industrial development is a decline in labor productivity. It is possible to solve this problem with the help of highly qualified personnel and large-scale modernization of all production sectors of the economy, but modernization should take place with state regulation. The increasing sanctions regime serves as a significant obstacle to technological breakthrough to achieve goals of advanced innovative development of Russia. The program "Digital economy of the Russian Federation" is being developed, within the framework of which the main goal is to create advanced industries that are competitive in the domestic and international market (Passport of the national program "Digital economy of the Russian Federation", 2020). This ecosystem is possible if specific features of the technological revolution "Industry 4.0" are taken in account, where information systems and digital modelling are put at the forefront with close interaction between the state and business. Currently, the fourth industrial revolution is taking place, which involves the general modernization of the economy and the widespread computerization of technological equipment. All this is possible if all the specific features of the country are taken into account and a set of measures is developed that integrate the industrial and digital environment.

2. Problem Statement

The digital economy development and the activation of technological development of industrial production are the most important factors of economic growth for both enterprises and the state. Digital technologies today determine a development trend of domestic production. Currently, there is a transition from the point-to-point implementation of digital technologies to their comprehensive development in industries, which will contribute to increasing labor productivity and import substitution. It becomes obvious that the digital economy is not only the application of digital technologies, the replacement of numerous work processes with software and automated complexes, but also a significant change in the economy structure. All these processes create both new risks and new opportunities. Russian enterprises are at the initial level of readiness to conduct new projects. At large organizations, money is invested in robotic systems, sensors, and the creation of infrastructure and networks. But the main problem is not the slow introduction of the latest technical means, but the lack of qualified personnel capable of managing business processes and production in general.

3. Research Questions

What are the prospects for the development of the digital economy in Russia? Why is the digital economy seen as an inevitable stage of economic development? How is robotics implemented at industrial enterprises? What challenges will the industry face in 2020? How to deal with this situation? How to ensure the competitiveness of industrial enterprises in the digital economy? What are the development prospects for the digital economy? At what stage of digital transformation are industrial enterprises? What does digitalization mean for industrial enterprises in the context of the formation of the digital economy?

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4. Purpose of the Study

The development of digital technologies is one of the most important tasks for Russian enterprises. For this purpose, state programs are being created, for example, "Development of the industry and increase of its competitiveness", which includes the creation of a balanced competitive industry that will be capable of effective self-development, the development of advanced technologies to increase the labor productivity (Government of the Russian Federation, 2014). This state program aims to reduce the dependence of Russian strategic machine-building complexes on the supply of foreign technologies, as well as increase the industrial production index (Zoidov et al., 2018).

In 2018, the density of robotics in Russia was equal to three, our country occupied the 17th place among such leaders as Korea (631), Singapore (488), and Germany (309). Undoubtedly, the sale of robots in the domestic market is growing, but not at a rapid pace as it is in developed countries. For example, in 2016, less than 400 robots were sold in Russia, while in China this figure was equal to 87 thousand. In 2016, Russia bought almost 240 times fewer robots than China.

In Russia, robotics is not widely used at industrial enterprises. For example, in 2018, the robotics density was 5 robots per 10,000 workers. Positive growth is going on every year, but, unfortunately, comparing the data with other countries, this indicator is very small. In the world, this figure was 99 robots per 10,000 workers, in Singapore - 831, Germany - 338, the United States - 140 per 10,000 people.

With the active use of robotics in Russia, the following situations are possible:

- costs for workers will be reduced (some production sites can perform such work as assembly, welding, cutting, cargo moving);
- material costs will be reduced (the product quality will be improved by replacing people with robots);
- the percentage of defective goods will decrease and the quality of products will improve;
- the productivity will increase, as robots will work longer than humans.

One of the most frequently used robotic technology industries is automotive (39%), because this process requires precision, complex operations with high algorithmization, the next industry is mechanical engineering, which includes almost 32% of robotic technology, 5% is used in R & D and education, and about 4% in the chemical and petrochemical industry.

The purpose of the study is to determine development directions of the digital economy and industrial complexes, to analyze the current state of economic transformation in the Russian regions, to identify prospects for the development of industrial enterprises in the context of economic transformation and key areas for improving the efficiency and competitiveness of the Russian economy. It is also important to analyze the state of economic sectors in Russia, to assess the contribution of digitalization to GDP growth, to identify problematic barriers hindering the effective development of digitalization of production processes in the machine-building industry.

5. Research Methods

The digital economy currently acts as a new type of economic relations in all segments and types of economic activity of the world market. Thus, the digital economy seems to be an inevitable stage in the development of the economy, as horizons expand and new opportunities for development open up. The

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research methods used in this study include analysis of statistical data, state and legal documents, scientific literature on the topic, synthesis, generalization. In the study, we used a systematic approach to the study of socio-economic phenomena. The studied aspects were considered in comparison with similar ones in other countries. The authors studied the penetration of digitalization in various sectors of the Russian economy, the features of digital transformation in Russia. The article also discusses issues of industry digitalization in the period of pandemic and isolation, new challenges and tasks that need to be addressed in the new changing environment.

6. Findings

Information technologies in 2020 faced new challenges associated with the epidemic. A lot of people have changed their habits due to isolation, their needs have changed too, the economy of countries has changed, and industrial production has been still suffering. In May 2020, there was a 10% reduction in production compared to the year 2019. Experts compare this decline with 2009. Thus, motor transport production was significantly affected, there was a decrease in April in annual terms by almost 60%, and in May – about 56%. The moderately affected industries are metallurgical production (in annual terms: April-87.1%; May-92.2%) and machinery and equipment production (in annual terms: April-88%; May-96.9%) (Domnina et al., 2021).

After the epidemic hit in the spring, the domestic industry fell by almost 8%, soon, it began to gain momentum monthly, but in October, due to the second epidemic wave, the industrial production index began its decline by 6%. The government of the Russian Federation predicts slow growth of the industry: in 2021 an increase of 2.6%, and in 2022 by 3.6%.

But in turn, COVID-19 gave a new impetus to the growth of informatization around the world. The main document of the Russian society transformation is the "Strategy for the development of the information society in the Russian Federation for 2017-2030" (Decree of the President of the Russian Federation No. 203 of 09.05.2017 "On the strategy for the development of the information society in the Russian Federation for 2017-2030") and the program "Digital economy of the Russian Federation" (Passport of the national program "Digital economy of the Russian Federation", 2020). In the framework of these projects, the central element is formed by goals, objectives and measures that determine the effective use of information technologies in the context of the national economy. According to some expert opinions, the program funds may exceed 3.5 trillion rubles. Thus, R&D direction occupies in the structure of internal expenditures the volume of 2.5%, the purchase of computer equipment – 13.6%. At the moment, the application of technological innovations is inherent in the industry, which is leading among the agricultural industry, the service sector and the construction industry. Pharmaceutical, chemical companies, as well as some segments of mechanical engineering are the most active sectors of innovative activities.

Every year we see how artificial intelligence (AI) modernizes production, improving its performance. The "forced reboot" for manufacturers was the 2020 pandemic. The search for new development ways, new resources is an urgent task for many enterprises to overcome bankruptcy. The most frequent implementation of artificial intelligence takes place in the areas of machine maintenance and quality assurance. For example, the company for the construction of marine equipment Caterpillar annually saves from 400 thousand US dollars per vessel. They analyze the data on the required frequency

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of cleaning cases to achieve the maximum effect. Another example is the company BMW, which uses artificial intelligence to detect deviations from the standard. Human experience, analytical information and AI methods are the key to successful competition in the market.

In Russia, after the pandemic isolation and a sharp decline in oil prices, according to experts, the mechanical engineering industry is expected to decline by 20%. In the automotive and aerospace industries, there was a decline of 11.6% and 12.7%, respectively. Government measures to stimulate demand in the automotive industry cannot help the industry for several years already. The unstable situation can also be traced in other industries. The analysis of industries is given in Table 1.

Table 1. Analysis of Russian industrial branches in 2019-2020

	The volume of the Russian market, billion rubles.		The volume of domestic production, billion rubles.		Export volume, billion rubles.	
	2019	2020	2019	2020	2019	2020
Machine tool construction	52,18	56,12	395,5	406,8	366,2	331,5
Power engineering, electrical and cable industry	9,94	12,49	368,4	362,9	181,7	172,03
Heavy engineering	2,03	1,95	82,2	78,2	34,3	28,5

Source: authors based on (Ministry of Industry and Trade of the Russian Federation, 2020)

The further industrial development of the Russian Federation requires a complex of special measures, among them there are not only the support instruments that are usually implemented by the state, but also the application of technological innovations, artificial intelligence, Big Data, computer technologies at enterprises. Organizational efficiency, profitability of operations and future prospects of industrial enterprises depends on their level of the digital potential. Today, the Internet of Things (IoT) is popular, with the help of which it is possible to train employees without additional personnel to analyze a large amount of information at the enterprise. Investment in the digital economy is growing every year. Only in the period from 2019 to 2021, more than 400 billion rubles were allocated, but, unfortunately, the development of funds is inefficient.

Modernization and digitalization of industrial enterprises are not becoming widespread in Russia, but "Industry 4.0" is growing at an incredible pace on the world market and will reach $ 157 billion by 2024. The growth of "Industry 4.0" is associated with the spread of the Internet of Things, enterprises increasingly use artificial intelligence, robotics, virtual reality, 3D printing, digital twins and 5G networks. The rapid growth of these technologies is being applied in the Asia-Pacific region.

However, there are barriers to the development of "Industry 4.0" in Russia:

- moral effeminacy of equipment;
- outdated technologies;
- lack of highly qualified personnel;
- incompatibility of advanced technologies and existing equipment in enterprises;
- insufficient funding and inefficient use of funds;
- insufficient motivation not only of the staff, but also of the management level.

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An essential prerequisite for the company digitalization is that the organization is provided with programming controlled equipment. Anyway, in the Russian Federation, very few enterprises have this equipment. CNC machines can be traditionally found in the aircraft industry, instrument making, and in the machine tool industry. If we compare the level of Russian technological capacities in this context with that in foreign countries (Japan, Germany, the United States, China), we can see how large the Russian lag is (Vishnyakova et al., 2020). As for the automotive and heavy machinery industry, these branches cannot reach even 10% of technological equipment in this context.

It should be admitted that the actual position of the Russian mechanical engineering is quite disappointing, as the output dynamics since 2014 has been negative. This situation may be explained with the fact that there is still a decline in domestic consumption. About 46% of machines have been operating at the Russian enterprises for more than 20 years, it means that they are physically worn out. The enterprise management is aware of the situation and takes measure to improve the current equipment state, but the problem also relates to the staff: the personnel at enterprises remains the same. Young people are not willing to work for industrial enterprises. While in European countries there are 0.8 workers per machine, in Russia, this figure is on average about 4.5 workers per machine, and these are experienced workers, but the figure itself shows that the labor productivity at Russian enterprises is low. Consequently, Russian products are not characterized as competitive ones.

R&D expenditures are measured as a percentage of gross domestic product in Russia. These expenditures are currently so unstable that they are slowing down the necessary transformation processes in the country. For example, in 2017, costs amounted to 1.11 as a percentage of GDP, and in 2018 they decreased by 0.11 (Federal State Statistics Service, 2020). But in turn, GDP growth is expected by 2030, thanks to digitalization. This is evidenced by the data of Table 2.

Table 2. Assessment of the digitalization contribution to GDP growth by cumulative total, %

	2019	2021 (forecast)	2025 (forecast)	2030 (forecast)
GDP growth due to other factors	1,3	3,5	10,2	17,8
Contribution of the IT industry	0,3	0,6	1,3	2,3
Contribution of economic sectors digitalization	3,0	5,6	11,1	18,4

Source: authors based on (Vishnyakova et al., 2021)

We can see that there is a certain decline in the innovative activity not only in separate spheres, but in the country as a whole. For example, the level of innovative activity in industrial production in 2017 was about 18%, and in 2018 it decreased to 15.6. The level of innovative activity in the Russian Federation as a whole decreased by 1.8% from 2017 to 2018. The increase in the growth of the need for innovations is evidenced by the costs of organizations. The cost of technological innovations of organizations had been growing from 2010 to 2018. In 2010, this figure amounted to almost 400,804 million rubles, and in 2014 – 1 211 897, by 2018 it grew by 260,925 million rubles (Dashenko, 2018).

But in turn, Russia has a number of positive forecasts in the industry, for example, in 2019, the company "Tsifra", which supplies artificial intelligence technologies and the Internet of Things for industry, and the company "UZTM-Kartex", which carries out strategic planning of production assets of Gazprombank, signed an agreement on joint supplies of digital solutions for heavy engineering. Selected

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work grounds are Uralmashzavod, "UZTM-Kartex" named after P.G. Korobkov and "OMZ-Foundry production", which are managed by "UZTM-Kartex". Almost immediately after signing, the implementation of the monitoring system "Dispatcher" began, and the issue of implementing AI projects was also raised.

AvtoVAZ widely applies digital technologies at all stages of car development, especially for "crash tests" (up to 80%). The manufacturer uses virtual modeling to calculate the aerodynamics, durability of the body and its rigidity. The company translates many processes into "digital", for example: simulates technological processes before launch, implements robotics. Today, there are 23 robotic complexes for 10 thousand employees. By 2025, robots will only add to the "labor force", there will be about 400 units, and by 2030 – 660 units (Vishnyakova et al., 2021).

7. Conclusion

Digitalization is a new development stage of our society on the whole and various industries that has already affected all socio-economic spheres. The most part of digital innovations is seen in the industrial production. The role of the state regulation in this context is great, as the digitalization may help in the solution of some urgent tasks in Russia. Among these tasks, there is a need in the production process acceleration, import-substitution, increase in the labor productivity. Industrial digitalization in 2025-2035 will take place in an abrupt form and will change engineering processes, which will entail changes in production management technology. The increase in production efficiency is possible due to the implementation of the adopted project for the creation of the TechNet technology park, which is an analogue of the German program "Industry 4.0". The Ministry of Industry and Trade of Russia predicts an increase in labor productivity by 30% by 2024, and exports in mechanical engineering will increase by 5% (Vishnyakova & Tatarskih, 2019).

The modern world is experiencing a huge information and communication revolution in the history of the modern society. To develop strategies for the digital economy development in the regions, technological changes should be taken into account in order to improve the welfare of citizens as much as possible. Of course, there are problems associated with the lack of effective use of electronic technologies by organizations and the population. The real entrepreneurial practice shows that the usage of digital technologies is not always effective, and the digitalization process is quite slow which is not enough for further economic development, as the country needs today rapid development in all industrial branches. Studies on the current development level of the Russian digital economy and its contribution to the country's GDP in comparison with some developed countries show a lag in many indicators, especially in terms of companies' investments in digitalization. The leader in the development of digital technologies is the United States.

There are some prospects for effective digitalization of the Russian economy, but one of the urgent task is to change the management philosophy: enterprise managers should be able to risk and be responsible for their decisions, leave their comfort zone and move towards the innovative development. Progress in the development of the digital economy is considered as a decisive factor for improving the competitiveness of industrial enterprises. The concept of "smart production" is familiar in our country, but first of all in transport, aircraft, rocket and space industries. At the largest companies of these

branches, there is a trend to apply automated quality control and energy management systems, instruments of standardized solutions etc.

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