Artículo de investigación

The Impact of The Industry Digitization on The Economic Development of The Country

Влияния Цифровизации Промышленности на Развитие Экономики Страны

El impacto de la digitalización de la industria en el desarrollo económico del país

Recibido: 03 de junio del 2019 Aceptado: 14 de julio del 2019

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Abstract

The article shows how the digitalization of industry influences the development of the economy and is able to change the structure of the world economic system, which includes the potential of buyers, the structure of industry sectors, and the significance of the state. The beneficial effects of the industry digitalization can be noted in all layers of society, from individual buyers to the state in general. The purpose of the work is to analyze the level of digitalization of industrial enterprises and the development of measures to improve this process, as well as to assess the impact of digitalization on the economic security of the state. When working on the topic, various general research methods were employed including analysis of legal documentation, classification, and generalization. The peculiarity of the industry digitalization is that the main resource is the knowledge, information, and technical and technological part of the digital base.

Keywords: Digitalization, digital space, industry, innovation, technologies.

Аннотация

В статье показано, как цифровизация промышленности оказывает влияние на развитие экономики и способна изменить структуру мировой экономической системы, которая включает в себя потенциал покупателей, устройство отраслей, значимость государства. Положительные эффекты от цифровизации промышленности присутствуют абсолютно во всех слоях, начиная отдельными покупателями, заканчивая государством в целом. Цель работы состоит в анализе состояния уровня цифровизации промышленного предприятия и разработке мероприятий по его повышению и оценки влиянии цифровизации на обеспечение экономической безопасности государства. При написании работы были использованы различные общенаучные методы исследования, анализ нормативно-правовой документации, классификация, обобщение. Особенностью цифровизации промышленности является то, что главным ресурсом выступают знания, информация и технико-технологическая часть цифровой основы.

Ключевые слова: Промышленность, цифровизация, технологии, цифровое пространство, нововведение.

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Resumen

El artículo muestra cómo la digitalización de la industria afecta el desarrollo de la economía y puede cambiar la estructura del sistema económico global, que incluye el potencial de los compradores, la estructura de las industrias y la importancia del estado. Los efectos positivos de la digitalización de la industria están presentes en absolutamente todas las capas, desde los clientes individuales hasta el estado en su conjunto. El propósito del trabajo es analizar el estado del nivel de digitalización de una empresa industrial y desarrollar medidas para aumentarlo y evaluar el impacto de la digitalización para garantizar la seguridad económica del estado. Al escribir el trabajo, se utilizaron varios métodos generales de investigación científica, análisis de documentos reglamentarios, clasificación, generalización. Una característica de la digitalización de la industria es que el principal recurso es el conocimiento, la información y la parte técnica y tecnológica de la base digital.

Palabras clave: Industria, digitalización, tecnología, espacio digital, innovación.

Introduction

Modern numerous assumptions about the role of information technology are associated with high expectations, assuming that their implementation will significantly increase labor productivity, which will serve a source for economic growth in general. This assumption is objective only with significant remarks. The genesis of new technologies can serve a reason for the emergence of a huge number of positive phenomena and results for the economy, such as the strengthening competitive advantage, establishing new markets, ensuring productivity growth, improving living standards, and increasing capitalization. The formation and extensive implementation of high-digital technologies are associated with certain challenges and risks. Among these risks, the main ones include reducing the level of data security, violating privacy, practicing potential surveillance of citizens, threatening to the digital sovereignty of the country, reducing the number of low- and medium-skilled jobs, increasing the level of complexity of business models and interaction schemes, increasing sharply competition in all economy sectors, as well as changing the behavior of both producers and consumers (Efimova, Kocherga, 2016; Veselovsky, 2017).

Methods

In the modern context, the most important global challenge is universal digitalization. Even now, digital technologies occupy an important place in the development of science, technology, and the economy around the world. Their importance as a development driver is clearly seen in the context of countries such as the USA, India, China, and Japan (World Economic Forum). Today, the task of ensuring the security of human resources, as well as companies and the state

itself becomes impossible without a high level of development of digital technologies and highly qualified specialists in the field of artificial intelligence, as well as machine learning and cryptography (Khoroshavina et al., 2018). For this reason, the issue of studying the impact of digitalization on economic security is so relevant. Among domestic researchers of the information economy these issues were studied by A. Anchishkin, L. Veger, L. Gatovsky, L. Glyaser, V. Elmeev, V. Zhamin, G. Zhiltsov, V. Zubchaninov, A. Konson, G. Lakhtin, A. Nikolaev, S. Pirogov, B. Trapeznikov, E. Avdokushin, V. Sizov, V. Cherkovets, and others. The information and statistical base of the work included statistical and information materials of the research team, the World Bank, the World Economic Forum, The Boston Consulting Group, legal acts of the Russian Federation, programs and development strategies of the Russian Federation, as well as monographs, specialized publications, scientific and practical literature, and study-related periodicals.

Results

The assessment of the current status of digitalization of the industry and identification of Russian market development trends are being conducted in Russia since 2011, although the program "Digital economy of the Russian Federation" (Mishurin, Sizov, 2018) has been approved only on July 28, 2017. In this program, the implementation of the assigned plans for the digitalization of the industry of the Russian Federation was provided through achieving by 2024 indicators for several groups:

1) With regard to the digitalization ecosystem:

- The successful operation of 10 or more leading companies competing in global markets;
- Successful implementation of 10 or more industry-specific digital innovations (such as digital health service, digital education, and smart city);
- The successful operation of 400 or more small and medium-sized businesses in the field of building digital platforms and providing digital services.

1) With respect to personnel and vocational education:

- Number of graduates of higher educational institutions specializing in information and telecommunication technologies should reach 110 thousand specialists per year;
- Number of graduates of higher educational institutions specializing in information technologies should reach 600 thousand people per year;
- The proportion of the population possessed digital knowledge should be 40%.

2) In relation to the creation of research competencies and scientific and technical developments:

- 30 Internet projects should be implemented in the field of the digital economy (with total cost not less than 100 million rubles);
- 10 domestic companies should be involved in the implementation of particularly large Internet projects (3 million USD) in the field of the most important international scientific and technological partnerships in the digital economy.

3) With regard to digital infrastructure:

- In the total number of households, 96% of households should have ultra-wideband online access to the Internet (at least 100 Mbit/s);
- Mass implementation of stable 5G generation cellular network technology should be carried out in cities with a population over 1 mln people.

4) With regard to digital security:

- 76% of Internet users at municipal and social institutions should actively apply security protocols of digital interconnection;
- The proportion of centralized administration of network traffic of the national Internet segment, routed by foreign providers and servers, should be 7%.

The beneficial effects of the digitalization of industry are present in all layers of society, starting with individual buyers, and ending with the state in general (Samorodova, Shutko, Yakunina, 2019). A model of the industry digitalization benefits is shown in Table 1.

Table 1. A model of benefits from the industry digitalization

THE BENEFIT FROM INDUSTRY DIGITALIZATION FOR THE COUNTRY IN GENERAL		
A new source of GDP growth		
Progressive growth in the number of jobs		
Better use of resources		
THE BENEFIT TO THE STATE	THE BENEFIT TO THE CONSUMERS	THE BENEFIT TO BUSINESSES
Increasing productivity and processes systematization (data management)	The ability to purchase the best goods and services at competitive prices	Simplifying access to new markets, increasing revenue
Reducing the likelihood of fraud while receiving public services	Easy access to public services via digital platforms	Increasing productivity of internal processes

Improving the efficiency of cooperation with citizens	The ability to use previously unavailable products	Using digital communication channels to employ the best workforce
Conducting analysis and authentication of modern social trends using big data	Availability of information on new employment opportunities	The tendency to increase openness when interacting with the state

Source: (Beilin, 2019)

The digital economy and society index was chosen to assess the level of digitalization of the Russian industry. Initially, the index was developed for EU countries (Babina S. I., 2019). It assesses the progress of countries towards industry digitalization, combining a number of relevant indicators. Consider the values of these indicators for Russia in the following dimensions: connectivity, human capital, level of use, integration of digital technologies, and digital public services. The data are presented in Table 2.

Table 2. Indicators of evaluation of digitalization of Russian industry

Dimension	Indicator	2018
1. Connectivity	The proportion of households with ultra-wideband online access to the Internet in the total number of households, %	70.7
	The proportion of households subscribing to broadband Internet access in the total number of households, %	59.3
	The number of subscribers for mobile ultra-wideband online access to the network per 100 of the population, people	71.1
	Coverage of populated areas by 4G, %	10
	The proportion of households covered by broadband, %	26.1
	The proportion of fixed broadband subscribers	17.9
	The monthly cost of broadband Internet access, % of average monthly income	0.2
2. Human capital	Proportion of the population, using the Internet almost every day, in the total population (aged 15-72 years), %	58
	The proportion of the population using mailbox, editing tools, installation of new devices, %	50
	The proportion of jobs, such as ICT service managers, ICT professionals, ICT technicians and installers, and ICT service providers, in the total number of employed, %	1.5
	People with a degree in science, technology, mathematics or engineering per 1,000 people	17
3. Level of use	The proportion of people, who used the Internet to read online news sites, newspapers or magazines (ages 16 to 74), %	63
	The proportion of people, who used the Internet to play or download games, images, movies or music, %	67
	The proportion of people, who used the Internet for Video on Demand services, %	6
	The proportion of people, who used the Internet to make phone or video calls (via Skype), %	31
	The proportion of people, who used the Internet to participate in social networks, %	63
	The proportion of people, who used the Internet for online banking, %	37

4. Integration of digital technologies	The proportion of people, who have ordered products or services online	61
	Enterprises, which use the enterprise resource planning (ERP) software package to exchange information between different functional areas, %	22
	Enterprises, which use radio frequency identification (RFID) technologies, %	4
	Enterprises, which use two or more of the following social media: social media, multimedia sharing websites, wiki-based knowledge sharing tools, %	8
	Enterprises, which send invoices in an agreed standard format (such as EDIFACT, XML), %	9
	Small and medium-sized enterprises (SME) engaged in online sales (at least 1% of turnover), %	26
	The total turnover of SMEs from e-Commerce, %	7.1
	SMEs that carried out e-sales in other countries	1.9
5. Digital public services	The proportion of the population, who used the Internet portal to receive municipal and social services in electronic form, in the total population aged 15-72 years, who have received state and municipal services over the past 12 months, %	51
	Amount of data pre-filled in online public service forms	12
	The proportion of administrative measures related to major life events (birth of a child, new place of residence, etc.), which can be done online, %	55
	The extent to which the country has an open data policy, %	51

Based on the collected statistics, it is possible to calculate the International Digital Economy and Society Index (I-DESI) for Russia. The indicators were aggregated into measurements, while measurements – into a general index from the bottom up using simple weighted arithmetic means.
Corresponding calculations were carried out by the following formula:

$$\text{I-}(C) = \text{C}(C) \cdot 0.25 + \text{HC}(C)\ 0.25 + \text{UI}(C) \times 0.15 + \text{IDT}(C) \cdot 0.2 + \text{DPS}(C) \cdot 0.15 \quad (1),$$

where I-DESI (C) was the Digital Economy and Society Index for a particular country; C(C) – the connectivity, HC(C) – the human capital; UI(C) – the use of the Internet; IDT(C) – the integration of digital technologies; DPS(C) – the digital public services.

Thus, we obtained the economy and society digitalization index for Russia equal to 0.47.

It should be noted that there is a slight error in the calculations since the economy and society digitalization index was developed for the EU countries, where statistics differ from the Russian one. However, this does not greatly affect the results, which can be used to compare the progress of Russia and the EU countries in the field of digitalization (Kozhevnikov, Wenger, 2018). The corresponding data are presented in Table 3.

Table 3. The International Digital Economy and Society Index for different countries

Country	Index	Including sub-indices				
		Connectivity	Human capital	Use of the Internet	Integration of digital technologies	Digital public services
	I-DESI	C	HC	UI	IDT	DPS
Iceland	0.66	0.69	0.66	0.61	0.73	0.68
Korea	0.64	0.81	0.75	0.29	0.47	0.73
Norway	0.63	0.70	0.65	0.45	0.66	0.63

Japan	0.62	0.71	0.66	0.22	0.67	0.71
USA	0.62	0.66	0.56	0.37	0.68	0.79
China	0.61	0.75	0.61	0.30	0.78	0.49
Australia	0.60	0.59	0.56	0.42	0.75	0.69
Canada	0.59	0.63	0.62	0.42	0.58	0.67
The EU-28	0.54	0.61	0.59	0.38	0.55	0.47
Russia	0.47	0.50	0.63	0.32	0.43	0.36

As a result, Russia falls into the middle of the second group (catching up) countries, such as Lithuania, Czech Republic, and France.

Almost all developed countries, aware of the inevitability of future changes, became active and began to move consciously towards digitalization of the economy. China and the United States were the first to move in this direction. At the moment, they are unofficial favorites in the digitalization race.

Next, together with the adoption of appropriate programs, a similar course was taken by the UK, EU, Belarus, Australia, etc. But while reviewing the strategic programs and development projects, it can be found that in fact they do not have in their composition the following aspects:

- Strategic ideology and a clearly defined concept of the industry digitalization;
- Specifically prescribed wording, interpreting all the provisions of the industry digitalization;
- Reflection of the impact on the current economy (with the exception of labor productivity);
- Reflection of key qualitative transformations that may occur in other areas.

Bringing together all these data, it becomes clear that the countries, including ones the most successful in terms of digitalization, lack a holistic view of the industry digitalization concept and its consequences. Most countries seem to regard the digitalization of industry as the latest means of communication and payment with buyers, but not as the latest methods of economic relations and management. It is obvious that many countries do not provide opportunities for the creation of digital transformation of industry, but simply practice in the digitalization of existing economic relations. Despite its obvious practicality, this initiative does not represent a targeted development of the digital economy.

It is important to note that the strategic programs of China and the United States have a subtext, which describes the new stage of globalization. The process of states integration for these countries, which in turn possess the two most powerful economies in the world, is of great importance and benefit since from an economic viewpoint, the most powerful player constantly gets a chance to re-realize their own advantage (Lakhtin, 2018).

While conducting a more detailed analysis of the United States strategy, one can see that the impact of the industry digitalization on the system of the digital economy development can be split into certain links. These are the formation of the digital economy conjuncture (legislative framework), the emergence of digital platforms in more prepared areas of industry, competitive rivalry among the platforms with their subsequent integration, and the dissemination of particularly successful business solutions to the economy in general.

For the United States, this strategy is justified because of the following provisions:

- This country has a significant scientific, technical and economic superiority in comparison with other countries of the world;
- In the course of building the industry digitalization infrastructure, the USA can use high-tech multinational companies, such as IBM, J.P. Morgan Chase, Intel, Hewlett-Packard, Microsoft, Google, and others as support when implementing digitalization.

However, from the standpoint of Russia, this strategy has obvious shortcomings, of which the main one is a long development period of the economy within the digital field.

Another informal leader is China. This country gave preference to a completely different strategy: the planned development of the digital economy. While considering China's strategy in more detail, it turns out that it includes a couple of almost non-overlapping courses.

This plan involves firstly production digitalization through the implementation of the industrial Internet. Secondly, the plan involves the use of Internet platforms to provide the future growth of markets. This policy includes four key blocks:

- Universal digitization of logistics and production;
- Building the legal framework;
- Digitalization of control systems, the formation of digital platforms;
- Merge of ecosystems and digitalization platforms into a single unit.

The implementation of this kind of project will certainly bring positive results for the digitalization of the industry, however, it does not contribute to the creation of a mature digital economy. For the Russian Federation, such policy contains obvious imperfections and shortcomings and thus is unacceptable (Schvab, 2018).

The strategy of the information society building in Russia describes that the process of promoting the digitalization of industry is a strategically important task, which establishes the ability of Russia to compete freely on the world stage. It is impossible not to agree that due to the technical and technological backwardness of the country, there are no conditions for the extensive formation of this sector of the economy.

A characteristic feature of the Russian economy is the fact that state-owned companies form a large part of the country's GDP. Due to such circumstances, a more effective solution would be the formation of a block of digital industrial platforms, managed by state companies and relevant departments. By means of such platforms, it would be possible to create a fundamental basis for the progressive growth of industry digitalization and the development of appropriate technologies (Ablyazov, Rapgof, 2019).

During the formation of such platforms, it is important to pay attention to the mainstream trends, namely, telecommunications, electric power industry, technical and technological infrastructure, transport, and information processing. The development of these areas will make it possible to form a scientific, technical, and infrastructure base. The extension of this base to other areas will allow Russia to develop rapidly the digitalization of industry, and to build a mature system of the digital economy.

The targeted creation of a series of high-industrial digital platforms with a holistic architecture and state standards, in the long term, will make it possible to build an indivisible digital sphere connecting all sectors of the economy (Grunin, 2015).

Today, Russia faces a challenging, however, quite an achievable task – to increase the scope of the digital economy three times from 3.2 trillion in 2015 to 9.6 trillion rubles by 2025 (Fig. 1). This can be done through the digitalization of industry that will require keeping the average annual growth rate of the digital economy at 16%.

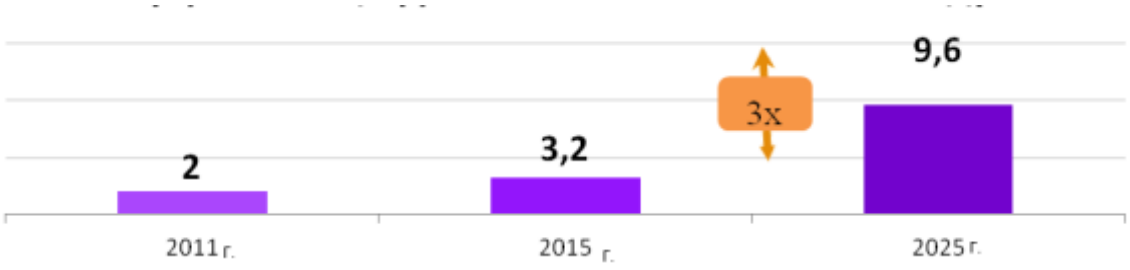

Figure 1. Target: tripling the digital economy in Russia.

The government course aims at the development and implementation of the digital economy, using the Industry-4.0 tools, which seems to be the only acceptable way to strengthen the strategic position of the Russian Federation in the international economy. The active implementation of digital technology will significantly reduce the gap between the countries leading in digitalization, and in addition, increase sustainable development in the long term.

Such economic forecasts depend not so much on the effect that the automation of existing business processes will bring, but on completely new advanced technologies and business models, which will be implemented in the future (Revenko, With, 2017).

To date, this method is fundamental for Russia, since it will increase the clarity, flexibility, and organization of the state economy in general.

The rapid development pace of digitalization virtually in all sectors and areas of society's life-sustaining activities creates prospects for the country's economy, and at the same time disseminates the issue of economic security (Piskunov, Glezman, 2019).

For many enterprises, economic security is a composite concept, which includes a combination of components related not only to the internal environment of the enterprise but also to external entities, with which the enterprise builds relationships. Today, at large state-owned enterprises there is an opportunity to create their own structural unit specializing in providing economic security. But, from a practical standpoint, a significant number of managers of these divisions lack a developed and effective academic concept of evaluation and ensuring economic security that significantly reduces the functional effectiveness of such divisions. (Aaltonen, Seiler, 2016; Veselovsky, 2018).

Economic security of enterprise means a system that guarantees the best regulation and mobilization of resources that ensure its effective operation, and contributes to its protection from external and internal threats. Therefore, for the enterprise, such a system is an important condition for strengthening the sustainability and development in an unstable environment. For example, when a company goes bankrupt, it loses monetary values, and at the same time crumbles business infrastructure, which includes material, technical and technological, managerial and information relations, as well as personnel and information security. Consequently, the issue of the formation of the enterprise's economic security system is relevant in the context of digitalization.

In light of the current situation, one should assume that providing economic security is a continuous process, which aims at the implementation of the strategy to eliminate potential losses and improve the financial, technical, technological, personnel, and information security of the company in the future. Thus, it is possible to achieve economic security and stability of the enterprise, perhaps, in the case of a multifunctional strategy with clear logical models for the rapid identification and elimination of possible threats (Scott, Varian, 2015).

Thus, according to the strategy of economic security of the Russian Federation for the period up to 2030 (Kelly, Liaplina, Tan, Winkler, 2017), the main threat is the delay in the implementation of modern digital technology. Consequently, in this strategic document, special attention is focused on technical and technological threats. Thus, the economic security of the enterprise is understood as the protection of its technological, scientific, technical, and digital potential from the threats that lie in the inefficiency of the industrial strategy of the country.

The essence of the digital component of the enterprise's economic security consists in the degree to which the technology used in this enterprise meets the best world standards. A significant aspect here is the ability of these technologies to develop and compete with interchangeable technologies that will contribute to the technological growth of the economy (Schuh, Potente, Wesch-Ponte, Weber, Prote, 2014).

The structure of the enterprise's digital security, its material sphere includes the following key stages:

- Analysis of the technology market relevant to product line manufactured by the enterprise;
- Analysis of in-house technological processes of the enterprise;
- Elaboration of the technological strategy of enterprise development;
- Operational implementation of technical development plans of the enterprise;
- Analysis of the outcomes from applying measures.

For enterprises of the non-economic sphere, the procedure for ensuring the digital component of economic security includes the provision of information and human resources, because ensuring security touches upon the activities aimed at increasing the number of professional skills of employees (Vishnivetskaya, Alexandrova, 2019).

When defining the level of digital security from the company's technological standpoint (Waldfogel, 2016), commonly criteria for assessing productive capacity are used which include the following:

- The number of licenses purchased and sold by the enterprise;

- The number of actual patents held by the enterprise;
- The proportion of products sold that meet the best world analogs;
- A similar indicator that meets the best world analogs, with respect to the models of technological equipment used at the enterprise;
- The proportion of equipment obtained based on license agreements.

However, a common approach to the establishment of the technical and technological component of economic security has not yet been formed but experts recommend distinguishing them according to the following directions:

- Reproduction and renewal of basic production assets (BPA);
- The productivity of BPA application;
- The level of BPA wear and tear;
- Frequency of technology updates;
- The novelty of applied science-manufacturing technology and equipment;
- Competitive advantage.

Due to the above directions that determine the components of the production sector, the system of indicators of the technical and technological component, as a digital basis for ensuring economic security, should include the following indexes (Morozyuk et al., 2017):

- The actual level of capacity utilization (BPA capital productivity);
- The regularity of the production pace (BPA retirement rate);
- Age structure and technical resource of the equipment (coefficient of renewal of BPA);
- The degree of depreciation of BPA (capital-labor ratio).

It should be noted that the technical and technological safety indicators themselves have no significant role, while important are their threshold values. Many of the indicators do not have a single maximum. However, each case is different, and for each case, there is an opportunity to determine the criteria and limits for the values of indicators, but for similar indicators, there should be general trends in the definition.

In order to assess the digital component of the enterprise from the technical and technological standpoint, it is proposed to use the indicators presented in Table 4.

Table 4. Indicators to assess the digitalization level as a component of enterprise economic security

Indicator	Calculation technique	Trend/acceptable value
Capital productivity	F_O= volume of products sold / average value of fixed assets for the year	The limit value is determined by the base period; the tendency to increase
Capital-labor ratio	F_l = fixed assets value / mid-annual number	The tendency to increase through the accretion of the technical capacity
Coefficient of renewal of basic production assets	C_r = value of the commissioned basic production assets / total cost of basic production assets at the end of the reporting period	Upward trend
Fixed capital depreciation ratio	C_d = depreciation of fixed assets / basic cost of fixed assets	Downward trend (the optimal value is less than 50%)
Retirement rate of basic production assets	C_r = basic cost of fixed assets disposed for the analyzed period / cost of fixed assets at the beginning of this period	Upward trend
Materials-output ratio	M_o = amount of material costs / production output	Downward trend (the optimal value is less than 30%)

ISSN 2322- 6307

Expiry ratio of the fixed assets	C_e = depreciated book value of fixed assets / initial value of fixed assets	Downward trend (the optimal value is less than 1-3%)
Fines for low-quality products	-----	Downward trend
The average life of the equipment (years)	-----	Downward trend (5 years)

At that, threats to the digital component of economic security can be external and internal.
The external threats include the following: the lack of reliable suppliers, the increase in the cost of resources that leads to an increase in the cost of products sold, as well as the lack of investment that, in turn, does not allow timely updating technology and equipment. The internal threats include the following: low-efficient organization of the production process, the low skill level of personnel, inefficient management of working capital, and a high level of depreciation of fixed production assets.

Due to the trend of increasing depreciation of fixed assets, the enterprise will be forced to update technologies and equipment. Problems related to the material resources operation efficiency also initiate the implementation of new equipment and technological processes into production.

Thus, for the enterprises, a key feature of providing digital security from the technical and technological viewpoint is their intensive innovative work, and consequently, innovative improvement.

From this, one can conclude that the results of intensive innovative work guarantee the digital security of the enterprise, as they cause the increase in the efficiency of the operation of material resources and fixed assets, increase the share of fixed assets renovation, reduce the level of defective goods, and consequently, of fines for poor quality products. Equally, this increases the level of economic security and contributes to the progressive economic and digital development of the enterprise.

Conclusion

Thus, the conducted analysis has allowed concluding that digitalization solves many problems in terms of both optimizing the business model and improving the reliability of the production process and the quality of the final product. Active implementation of digital innovations in production has begun in 2011 when the concept of "Industry 4.0" was announced in Germany (Eurasian Resources Group). Today, the process continues to gain impetus and already has seriously affected the real sector of the Russian economy.

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