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Peculiarities of development of industry 4.0 concept in Russia

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Abstract. The world economy has been at the stage of active development of the fourth industrial revolution in recent decades. The issues of transferring national industry to the digital technology platform become particularly relevant under conditions of beginning of the competitive struggle of countries in the sphere of implementation of the Industry 4.0 concept. This study traces the history and background of the industrial revolution, identifies its main features and the most progressive technologies. The peculiarities of the development of the industrial revolution in Russia and abroad are analyzed. The experience of foreign countries in the implementation of state programs in the field of Industry 4.0 is considered. Examples of the implementation of industrial Internet projects on the Russian and foreign markets are given. Factors hindering the implementation of the industrial Internet projects in Russia are contemplated. Priorities are formulated and the prospects for the development of the industrial Internet in the Russian economy are assessed.

1. Introduction

Currently, the world economy is at the stage of formation of the fourth industrial revolution designed to raise the industry to a new qualitative level. The industrial Internet is becoming the main driving force of the industrial revolution and is one of the main factors for increasing production efficiency. The development of projects in the field of industrial Internet will lead to an increase in the level of industrial productivity, bringing a huge economic effect both for the world economy and for the national economy [1]. Effectively taking root in the activities of industrial enterprises, the industrial Internet brings fundamentally new cyber-physical approaches in the organization of production, service and management. As a result, the coming changes will affect not only the industry, but many other aspects of social life associated with it, such as labor market, educational system, living environment, political systems, and much more [2]. That is why the development of the industrial revolution and its introduction into the economy attracts the attention of scientists and politicians of many countries.

In recent years the industrial Internet, as an integral part and the most important direction in the development of the industrial revolution has been effectively introduced into the activities of Russian industrial enterprises [3]. Many large-scale projects have been launched and are successfully operating, and a platform is being created for the development of the industrial Internet. However, along with evident success in the development of the industrial Internet in Russia, there are some difficulties in its introduction into the industry [4]. The purpose of this paper is to analyze the current



state and prospects for the development of the Industry 4.0 concept at the Russian enterprises. In order to achieve the goal, the solution of the following tasks is required:

1. Assessment of the current state of development of the Industry 4.0 concept in Russia.
2. Analysis of the level of readiness of Russian enterprises for the implementation of the Industry 4.0 projects.
3. Analysis of factors hindering the implementation of industrial Internet projects in the Russian economy.
4. Development of priorities for the development of the industrial Internet in Russia.

2. Theory. Concept of industrial revolution development

The theoretical basis of this paper is the research of leading Russian and foreign scientists in the field of methodology of the industrial revolution and the practice of its introduction into the economies of various countries, including Russia. Particular attention in the study of theoretical and practical ways of the industrial revolution is paid to the analysis of the results of international forums and conferences on the development of the Industry 4.0 concept. The concept of the fourth industrial revolution called Industry 4.0 was formulated for the first time at the Hannover exhibition in 2011, defining it as the introduction of “cyber-physical systems” into factory processes [5].

In 2011, the United States began to develop the Cloud Strategy program [6], which goal was to implement modern technological ideas in the direction of creating “smart” industrial enterprises. In 2010, the European Union embarked on the development of the Digital Agenda for Europe program [7]. In 2016, the Eurasian Economic Commission presented a program for the development of the digital industry “Digital Single Market – Digitizing European Industry: Questions and Answers”. In China, in 2015, the “Internet plus” concept was adopted, which included the best initiatives of the leading countries of the world in introducing the functions of Internet governance in industry, finance, medicine, agribusiness.

According to the World Economic Forum in Davos the development of the main technological directions underlying cyber-physical systems, such as the Internet of things, cloud and quantum computing, big data, biotechnology, autonomous robots, virtual and augmented reality, 3D modeling and 3D print can bring more than 30 trillion US dollars for the global economy in the next 10 years [8].

The works of modern scientists solve the problems of the industrial revolution, the search for ways of development, the study of the consequences of the impact on the economy and social life of society. The common problems of the new industrial revolution are highlighted in many works [9–11]. The papers [12, 13] investigate the impact of the Internet of things on the transformation of industrial production. The issues of direct implementation of the Internet of things at the industrial enterprises are discussed in work [14]. The impact of the industrial Internet on the competitiveness of various industries is estimated in works [15, 16]. The issues of working with big data with the help of Internet technologies are considered in work [17]. Studies of the socio-psychological and economic implications of the introduction of intelligent technologies are considered in works [18, 19]. However, it should be noted that modern scientific literature pays insufficient attention to the analysis of the characteristics of the development of the industrial Internet in the Russian economy. Assessment of the current state and development prospects of the Industry 4.0 concept at Russian enterprises determines the relevance of this study.

3. Methodology

The works of leading domestic and foreign scientists in statistics, theory of market economics, financial and economic analysis, and modern information technologies for data storage and processing make the methodological basis of this research. The methodology for studying the development of the industrial Internet in Russia is based on an analysis of world experience in implementing the Industry 4.0 program, as well as on the analysis of statistical data on the introduction of the industrial Internet at Russian and foreign enterprises.

The assessment of the current state of development of the Industry 4.0 concept at Russian enterprises is made on the basis of the integrated economic and statistical analysis of the state of Russian industry and the assessment of current trends in its development using the methods of mathematical statistics and expert assessments. The research was carried out on the basis of data from the state statistical reporting. The statistical tooling of the study included methods of analytical grouping, correlation analysis, methods of mathematical prediction and trend analysis.

The analysis of the level of readiness of Russian enterprises for implementation of the Industry 4.0 projects is based on the method of assessing the Industry 4.0 maturity index developed by the German National Academy of Science and Technology Acatech [20]. The use of this method helps setting the current level of readiness of manufacturing companies to the Industry 4.0, as well as identifies areas in which further action is required. The method involves the systematic identification of weaknesses and capabilities of the enterprise, and serves as the basis for manufacturing companies to develop an individual plan for the implementation of the Industry 4.0 concept, corresponding to their business strategy. The Acatech Industry 4.0 maturity index helps determining at what stage of transformation into a developing, flexible company the enterprise is at the moment. This method allows carrying out an assessment from a technological, organizational and cultural point of view with a focus on the business processes of manufacturing companies. When using this method, each company needs to make a strategic decision regarding the specific benefits it wants to achieve, its priorities and the sequence of actions taken. As a result of the application of this methodology, the main shortcomings and difficulties in the implementation of the Industry 4.0 concept are identified, and an action plan is created to develop a general digital conversion strategy for the enterprise as a whole. The sequence of application of this approach is given in figure 1.

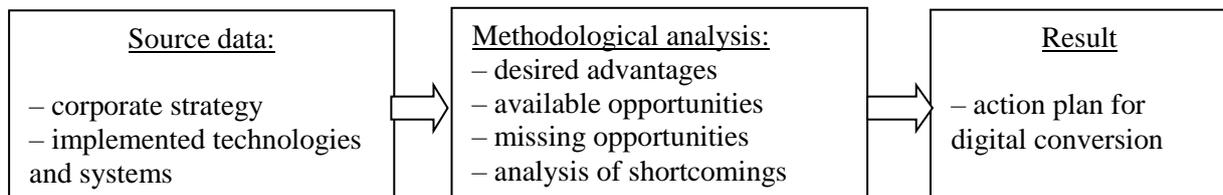


Figure 1. Methodological Analysis of Company's Maturity Index on Digital Conversion.

This methodological analysis provides an opportunity for complex analysis and defines a number of guidelines that allow companies to determine, which characteristics for the implementation of Industry 4.0 projects they still need to develop.

Analysis of factors hindering the implementation of industrial Internet projects in the Russian economy, as well as the development of priorities for the development of industrial Internet in Russia is based on using the results of companies' maturity index research in implementing the Industry 4.0 concept, as well as a statistical study of trends and development prospects of individual enterprises, industries and industry groups. The methods of correlation analysis and the methods of expert estimates were used as the statistical tools of the study.

4. Results and discussions

The analysis of the world experience of the implementation of the Industry 4.0 program presented in the theoretical part of the study, characterizes its development as an irreversible process. According to the forecasts of the McKinsey Global Institute, the contribution of the industrial Internet of things to the global economy may be about 11% of world GDP by 2025. The average annual GDP growth as a result of pessimistic and optimistic forecasts of the spread of the Internet of things can range from 3.9 to 11.1 trillion USD by 2025 [11]. Statistics show that the industrial Internet is increasingly used in the world practice. Analysts from Ericsson predict that about 16 billion out of approximately 28 billion connected devices worldwide will have been connected to the Internet of things by 2021. Analyzing the world experience of the implementation of the Industry 4.0 program, it can be concluded that the

introduction of new technologies in the industry is at the stage of active development. In order to increase the competitiveness of the Russian economy, it is necessary to ensure the transition of the national industry to a new digital technology platform.

Let us consider the peculiarities of the introduction of industrial Internet in Russia. Note that the Russian market of the introduction of industrial Internet is at the initial stage of its development. Using the methods of mathematical statistics based on a comprehensive analysis of state statistics of the Russian Federation, we can conclude that the share of the industrial segment in the Russian market of the Internet of things prevails. In 2015, its share was 64%, while the cross-industrial segment was 20%, and the state and consumer segment was about 8% [21]. This indicates good prospects for the development of industrial Internet technologies in Russia. In addition, it should be noted that the introduction of industrial Internet technologies among Russian companies vary greatly depending on the region [23]. Analysis of the Russian market of the industrial Internet of things based on a study of the trend line of its development showed that it amounted to 17.9 million devices in 2016 and increased by 42% compared to 2015. The total number of IoT devices will have increased to 79.5 million by 2021, and to 164.7 million by 2026. The widespread introduction of industrial Internet will increase global GDP by 10–15 trillion USD in 20 years [22].

An analysis of the level of readiness of Russian enterprises for the implementation of Industry 4.0 projects carried out on the basis of the Acatech maturity index estimation method showed that despite the clearly expressed desire to introduce digital technologies at their enterprises, there are also objective difficulties hindering their implementation in Russian enterprises. According to a survey of executives of companies from various sectors of the economy as a whole across the Russian Federation, about 32% of companies surveyed in mid-2017 confirmed their desire to introduce IoT technologies, 11% of companies have already implemented projects using the IoT in their companies, while 57% of the respondents said they did not use the Internet of things technologies [24].

The results of the analysis also showed that, at present, its use is more characteristic of systems for automated data collection from devices at industrial facilities. For example, in engineering, energy production, mining industries. The area of machine-to-machine interaction primarily develops among transport companies that use navigation systems effectively. An increase in the share of organizations that use information management systems in production can be noted as a positive trend. The percentage has increased from 25 to 30% from 2012 to 2017. First of all, their introduction is noted in the communications, chemical, electrical, and metallurgical industries.

A methodological analysis of the readiness of enterprises for digital reforms in accordance with the methodology for analyzing the weaknesses and capabilities of the enterprise (see Figure 1) made it possible to identify factors hindering the integration of industrial Internet projects into production in the Russian economy. According to the majority of enterprises, the main factors include low awareness and insufficient availability of technology, limited funding, lack of qualified personnel capable of servicing new technologies, lack of regulatory framework in the field of IT, low degree of development of security issues, information security when working with data, mindset of people, bureaucracy. Ensuring the availability and security of the use of advanced technologies for processing big data, cloud and quantum computing systems, the ability to use “smart devices”, robotics, computer management systems is the primary task of business and government, which implementation will lead to the involvement of an increasing number of enterprises in the Russian industrial Internet system.

Based on the results of the research cited above, we will formulate priorities for the development of the industrial Internet in Russia. The first thing that can be recommended to Russian companies planning to implement industrial Internet projects is the creation of a digital model of the production business process. A key factor in this process is the effective data management. The elimination of digital gaps in the production cycle is just the prospect for the industrial Internet. One of the leaders in this field in Russia is Rostelecom, which acts as an engineering center for digital support of the product life cycle. Currently, Rostelecom is creating a platform for the industrial Internet, which is being developed proceeding from an analysis of the best practices of the developed countries and taking into account the specific features of the Russian market. The National Association of Industrial

Internet Market Participants was established with the participation of Rostelecom. The creation of an industrial Internet development strategy in the Russian Federation currently involves such public and state organizations as the Ministry of Industry and Trade of Russia (the development of a roadmap for the development of the Internet of Things with the participation of the Internet Initiatives Development Fund (IIDF)). However, the issues of organizational and legal support for the innovation-oriented enterprises as part of development of information and communication technologies are currently worked out to a limited extent and insufficiently.

Thus, the priorities for the development of the industrial Internet in the Russian Federation are as follows:

1. Creation of information and telecommunications infrastructure providing technological opportunity to use new Internet technologies.
2. Public or public-private financing of the implementation of Internet of things projects. Pilot project support.
3. Support for domestic development agencies of high-tech products, research in the field of creating artificial intelligence, management information systems, and networking.
4. Ensuring the availability of the IoT platform for data collection and processing.
5. Reconstruction of the education system and training personnel in the field of IT.
6. Development of a regulatory framework conducive to the development of new technologies, ensuring their legal validity and protection of information.
7. Development of uniform standards and requirements for new products. Guaranteed compatibility with IT-systems, exports development.

5. Conclusion

Transition of the national industry to a digital technology platform is becoming a major issue for improving the competitiveness of the domestic economy. The analysis of statistical data showed that the Russian market for the introduction of industrial Internet is at the initial stage of its development. A peculiarity of the introduction of the industrial Internet in Russia is the predominance of the industrial segment in the Russian market of the Internet of things. This indicates good prospects for the development of industrial Internet technologies in Russia. An analysis of the level of readiness of Russian enterprises for the implementation of Industry 4.0 projects showed that, despite the clearly expressed desire to introduce digital technologies in their enterprises, there are also objective difficulties hindering implementation thereof at Russian enterprises. In particular, it was found that the main factors hindering the integration of the industrial Internet into production in the Russian economy are low awareness and accessibility of technologies, limited funding, lack of qualified personnel, insufficient regulatory framework in the field of IT, low development of protection issues information when working with data. The effective solution of the priority tasks formulated by the authors for the development of the industrial Internet in the Russian Federation will enable to intensify the implementation of industrial Internet projects and the development of the Industry 4.0 concept at Russian enterprises.

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