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Prospects for the Implementation of Industry 4.0 Trends in Russian Industry

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***Abstract*—In this article the authors aim to assess the state and prospects of Russia's Industry 4.0, as well as to identify the main problems hindering its development. According to the authors, the main changes in the organization of industrial production caused by the introduction of Industry 4.0 includes the active use of digital platforms; the formation of a single digital space for all participants in the production process, including the consumers of related products; the growth of data sets; and, digital support of the product life cycle at all stages of value creation. The introduction of Industry 4.0 in Russia is associated with the emergence of a number of problems (technological, economic and social), which can be eliminated with the help of an active state industrial policy.**

Keywords: Industry 4.0, digital economy, digital technology, IT platforms, smart manufacturing

I. INTRODUCTION

The introduction of digital technologies in production, within various sectors of the economy, requires a different operational paradigm. After a period of active deindustrialization, organizations began introducing industrial robots, additive technologies and information and communication systems into production processes; this led to the intellectualization of production and the formation of Industry 4.0.

Industry 4.0 is the fourth industrial revolution that began in 2011 and will soon change the world beyond recognition. The term "industry 4.0" was coined by the German Federal government as a strategy for the development of German industry, and means to unite industrial equipment and information and communication technologies into a single information space, wherein they autonomously interact with each other and with the external environment.

The fourth industrial revolution is defined through the Internet of things, cloud computing and cyber-physical systems. In his interview for IK4-TEKNIKER, German Professor E. Abele highlights several features of "Industry 4.0": compatibility, virtualization, decentralization and real-time operation [1]. The phenomenon of Industry 4.0 has been described by many researchers. For example, in the works of Gerbert P., Lorenz M., Rüßmann M. [2], industry 4.0 is presented as a transformation of industrial production, involving the connection of a single system of industrial equipment, cyberphysical technologies and sensors both within one enterprise and in the General cybernetic space. The study of Meissner H., Ilsena R., Auricha J. C. [3] focuses on the connection of ICT and industrial equipment which are conceptualized as "smart enterprise". Some authors are trying to assess the possibility of actively introducing smart technologies into Russian industry, which is under the influence of sanctions [4].

The aim of our work is to assess the state and prospects of Industry 4.0 in the Russian industry, as well as to identify the main obstacles impeding the proliferation of "smart industries".

II. MATERIALS AND METHODS

This research is based on the analysis of theoretical approaches, statistical data and positive experiences of Russian industry in a variety of sectors incorporating elements of Industry 4.0, as well as the study of foreign experience, comparative analysis, content analysis and surveys with the top managers of leading Russian enterprises.

The novelty of the author’s approach sucks in the fact that digital technologies are considered, first of all, as a global process that leads not only to the transformation of Russian industry, but also to revolutionary changes in all areas of human activity. Ultimately, the success of the introduction of smart manufacturing depends on the balance of these changes.

III. Discussion and Results

All researchers emphasize that the introduction of cyberphysical technologies imposes specific requirements not only for production, which must be flexible in order to quickly adapt to the manufacture of new products, but also on the organization of production, which is now based on potential real-time information exchange, remote management of value chains, changes in the number and competencies of personnel involved in the production process. In such systems, management decision-making is based on the use of simulation models, or even virtual "twins" of the production process.

At the heart of Industry 4.0 is the connection of the physical and virtual worlds, which is implemented by means of a cyberphysical system that connects the physical processes of production or other processes (for example, control of transmission and distribution of electricity), requiring the practical implementation of continuous control in real time, with software and electronic systems. As a result, there is a close interaction of physical system elements with built-in computing resources. The formation of Industry 4.0 is impossible without the improvement of scientific approaches and methods for organizing production.

First, there is an active development of digital platforms. The digital platform is created for multilateral interaction of users to exchange information in order to optimize business processes, as well as reduce overall transaction costs and improve the efficiency of supply chains of goods and services. Several digital platforms are combined into an ecosystem that creates the conditions for the exchange of digital services and applications.

In the digital economy, the organization of production is "a set of methods, techniques and measures to ensure the most effective combination of highly qualified workers with the necessary competence in the process of work with innovative means and objects of labor in space and time to achieve the goals of production on the basis of digitalization of product life cycle management"[5].

According to analysts, the use of digital technologies in the organization of production allows enterprises to make more profits than competitors by an average of 26%. The introduction of digital technologies allows us to move away from mass production and implement personalized "customized" production for each individual consumer, and products that are competitive not only in the domestic but also in the world market. At the same time, production costs are radically reduced due to the increase in the efficiency of production processes.

Secondly, digital platforms help organize the process of planning and production in a single digital space on the basis of simulation models (digital "twins"). All product information (manufacturing technology, maintenance, disposal, drawings and product specifications) should be digitized and available to all participants in the production process (both robots and humans). This problem is solved with the help of special labels (chips), which are read by robots and contain information about the necessary product adjustments at each stage of the manufacturing process. All this makes it possible to significantly reduce the time between product development and the time of its delivery to the consumer, while significantly reducing design errors, since they can be detected at the early stages of modeling in a virtual environment, which allows you to repeatedly reduce production costs. For example, Germany, one of the leaders in the field of digitalization of production, through the introduction of cyberphysical systems in production processes, intends to increase their productivity by more than 50% while reducing the consumed resources by half [6].

Digital "double" can be considered as an electronic passport of a product, which not only stores information about its technical characteristics and manufacturing process, but also gives complete information about the quality of the product to the customer. The manufacturers of a product, thanks to the chips, will be able to monitor product operation and carry out individual maintenance programs, and the consumer (customer) can monitor all stages of the production process and make adjustments to it.

Third, the use of digital technologies for organizing production increases avalanche information flows, with which the staff can no longer cope. Information processing is carried out by means of computers that read information using special sensors installed on the equipment and process it in real time. "The process of collecting, exchanging, processing, analyzing information allows to diagnose the state of the production system, forecasting, comparing and selecting solutions, automatic configuration and adaptation of equipment. Elements of cyber-physical systems can be in a single production zone, and away from each other, and their interaction is carried out at all stages of the life cycle of products" [7].

Fourthly, digital technologies support all stages of the product life cycle, from market research and production of goods to the promotion of products on the market and exit it. The main requirement for digital production is the interactive information support of the entire production system, the presence of which allows you to capture all business processes in the digital environment, which makes it possible to implement their joint use by the participants of the production process, as well as to accumulate experience that will be available to each next user. Consumers and producers of products are included in a single value chain. Integration of production becomes not just vertical or horizontal, it becomes comprehensive. Digitalization of product life cycle support imposes new requirements for training not only the production person and his competencies, but also to the competencies of customers and end users.

Fifth, the development of digital technologies requires closer cooperation between universities, research centers and enterprises, as modern production is characterized by the increasing complexity of industrial equipment, and also requires serious training in the field of information technology and teamwork. The introduction of the concept of "smart" production at the enterprise is a complex, long, expensive, but necessary process, which is designed to become part of the development strategy of the enterprise.

It should be noted that digital technologies of Industry 4.0 are actively introduced in the Russian industry. For example, in the textile industry, the most promising areas, in terms of the use of "smart" technologies and organization of production, in our opinion, are: the production of non-woven multilayer materials with predetermined properties; the development of new models of clothing and patterns for its production in small batches, as well as for the production of single models in an industrial way; printing clothes according to specified parameters; and, the production of technical textiles.

The creation of modern types of clothing requires new approaches to the organization of production and technological innovations. There is clothing that reacts to changes in weather conditions, the mood of the owners, and can even charge mobile devices. These developments force designers to take a new approach to the development of innovative forms of modern consumption, combining the individual requirements of the owners and the possibility of new materials.

For example, in the laboratory of Federal State Educational Institution of Higher Education "Russian State University. AN Kosygin (Tech. Design. Art) "[they use] 3D printing for the manufacture of clothing models, shoes and accessories made of hardened powdered nylon, as well as a lighter and more elastic material – ElastoPlastic elastomer.

Modern sewing enterprises are now moving towards 'to order' clothing models, involving in the process of designing clothes with external participants (fabric suppliers, customers, suppliers of accessories, etc.) but don't have the opportunity to increase the cost of production. One of the main trends of modern production is the need to reduce the lead time of orders for the production of clothing. Therefore, already at the stage of product design, many manufacturers outsource part of the operations, leaving behind only the development of the basic concept of the product. However, the use of different companies for the design of products and their parts makes it extremely necessary to monitor and control the entire design process, and this requires an integrated collaborative environment where each participant has access to information and can make changes to the product in accordance with the regulations.

All these problems are solved by creating digital factories in the fashion industry, which help: significantly reduce the time and cost of designing new products by direct virtual modeling and direct 3D design of both fabric and the garment itself, assessing the comfort of the product and its landing on virtual mannequins, calculating the estimated cost of production of the product; automating decision-making and reengineering business processes for core activities to enhance quality; quick response to changes in customer requests and optimization of logistics processes; and, provide end-to-end document flow with the possibility of full access of customers.

The firm "BASK" is an example of embedding digital technologies in the modern production of clothing. BASK built a pilot plant for the production of clothing with digital technology properties in CALIBER Technopark in Moscow.

The BASK firm produces 300 models of unique technological clothes. The company develops the most complex and expensive semi-finished products on its premises, and outsources the rest of the operations to third-party factories. Product demonstrations and personnel training are carried out at the Moscow site. To maintain a common information space, the company uses tools like "Graphis" – CAD, "IMA" – a fully digital cutting complex, JUKI – a world leader in sewing equipment, etc.

Despite the active actions of market participants and the understanding of the need for the development of "smart enterprises", the pace of implementation of industry 4.0 remains insufficient. According to BCG experts, the share of the digital economy in Russia is 2.1 % – 1.3 times more than five years ago, but 3-4 times less than the market leaders [7]. According to researchers of the Russian Association of electronic communications (RAEC), the contribution of the digital economy to Russia's GDP in 2017 was 2.1%, and together with the mobile segment – 5.06% or 4.35 trillion. RUB The indirect contribution of the mobile economy to GDP is 1.76 trillion rubles. 0.54% of GDP is accounted for by small businesses in the mobile economy. The question remains: is it possible for Russia to become globally competitive in Industry 4.0?

Best practices show that Russian business as a whole understand that without the use of digital technologies and the transition to Industry 4.0 it is impossible to compete successfully in domestic and foreign markets. At the same time, the development of "smart production" once again exposed the existing problems in the Russian economy and revealed new ones.

First of all, it is the lack of resources in many enterprises to implement projects and maintain these systems. The country lacks skilled labour and users who are able to use innovative technologies correctly and effectively. Also, pervasive conservative thinking means innovative solutions don't always resonate with suppliers and consumers. In some cases, the limiting factor is the poor ecosystem (the impossibility of Internet access, lack of data centers, etc.). Weak technical development and the weak pace of "digitalization" of the economy as a whole is a major problem hindering the development of the digital economy.

Russia is characterized by a relatively low index of intelligent robotics. According to statistics, out of 254,000 industrial robots sold in 2015, only 550 units were purchased for use in Russia. If the average global level of the number of robots per 10,000 employees is 69, in Russia it is 1 [8].

If the country accelerates the automation of current economic processes and uses fundamentally new, breakthrough business models and technologies, then, according to McKinsey, the digitalization of the Russian economy will increase the country's GDP by 2025 by 4.1-8.9 trillion. This will increase the total expected GDP growth from 19 to 34% [8].

Active implementation of digital technologies needs state support in such areas as:

1. Creation of infrastructure and private incentives by the state. These options include; additional tax incentives for the development of digital technologies, reduction of insurance premiums for the growth of it companies, the introduction of tax incentives for the amount of capital investments in modernization (digital technology), and the settlement of taxation issues in cross-border online trade.

2. Training and development of digital culture. The widespread development of the digital economy will cause changes in the structure of employment and the requirements for the qualification of workers. We need specialists, programmers, qualified users who are able to work in the digital environment. The digital economy will also affect top managers, who will need to understand how to carry out digital transformation of business processes.

3. Collaboration between state and the media to prepare citizens for future changes, the implementation of a broad digital education.

4. Ensuring cybersecurity. This requires the development of legal norms to combat cybercrime, technological solutions and standards, the creation of a staff of qualified cyber police.

5. Financing of new technological solutions from the budget, attraction of non-state sources of financing of exploratory research, stimulation of development of corporate science, training of heads of the scientific organizations capable to combine qualities of the scientist and the businessman.

6. Promotion of domestic new IT products and services to foreign markets by providing marketing information, organization of participation in foreign exhibitions and conferences, allocation of subsidies and guarantees for export credits, compensating the costs of patenting, forming investment funds aimed at conducting M&A (mergers and acquisitions) transactions abroad.

7. Promotion of cross-border cooperation. Restrictions on international cooperation are rapidly undermining the competitive position of domestic producers. Russian users must be able to use the services offered by the world market, possibly via unclassified, cross-border data transmission. This will encourage Russian companies to develop global technological alliances, forming the technological standards for the future.

Currently, the state program "Digital economy of the Russian Federation" (app. order of the Government of the Russian Federation dated 28.07.2017 № 1632-p), which was a logical continuation of the previously adopted programs: Federal target program "Electronic Russia (2002 - 2010)" (app. post. Government of the Russian Federation from 28.01.2002 № 65), the State program of the Russian Federation "Information society (2011 - 2020)" (app. post. The government of the Russian Federation of 15.04.2014 No. 313), the Strategy of information society development in the Russian Federation (UTV. President of the Russian Federation 07.02.2008 № PR-212, and the decree of the President of the Russian Federation from 09.05.2017 № 203 recognized invalid). This program is aimed at the implementation of the "Strategy for the development of the information society in the Russian Federation for 2017 – 2030" (app. Decree of the President of the Russian Federation from 09.05.2017 No. 203).

In addition, bodies have been established to manage digital economy: the working group of the economic Council under the President of the Russian Federation in the direction of "Digital economy" (decree of April 3, 2017), Council for legislative development of the digital economy under the Chairman of the state Duma of the Russian Federation (first meeting was March 20, 2017), a Working group on the elaboration of the President's instructions following the address to the Federal Assembly in the Ministry of the Russian Federation and the Ministry of communications of the Russian Federation, the working group "Communication and information technologies" of the Expert Council under the RF Government, companies and non-profit organizations : The Russian Association of electronic communications, the Center for strategic research, the Agency for strategic initiatives, the development Fund of Internet initiatives, "Rostec", "Rostelecom", "Sberbank", "Yandex".

However, it should be noted that the rapid development of Industry 4.0, stimulated by state support, along with the benefits incur certain problems that manifest wherever it is deployed.

In the most General form, the challenges of "smart production" in Russia can: reduce the number of vacancies of low and medium qualification; threaten security, due to the underdevelopment of protective technologies; tighten competition in all spheres of the economy; threaten "digital sovereignty" of the country; violate human privacy; complicate business models and schemes of interaction; change the models of behavior of producers and consumers; and, requires revisions to legal frameworks [9].

A significant disadvantage of digitalization is the transformation of jobs, which can lead to an increase in technological unemployment. Chairman of the Board of Sberbank G. Gref gave an example that, as it turned out, the neural network prepares claims better than a person. This led to a reduction of 450 lawyers of the Bank. This situation is fraught with growing social tension and depressive phenomena in society [8]. According to the research center of recruiting portal Superjob.ru the country faces an explosive increase in unemployment due to the fall in demand for low-skilled labor, and 2017 is the last year when the market recorded an increase in the number of jobs available to citizens, and the growth rate itself will decrease from 47% to 5%.

According to the Center for macroeconomic analysis and short-term forecasting (CMASF), digitalization, by 2030, "will release" 12.5 million workers. The deterioration of the demographic situation absorbs only 1.5 million of them, 3.5 million people can take small business. For the rest, the problem of employment will be acute.

Digitalization can provide a "two-three-fold increase in labor productivity" in the Russian economy, but if it is not transformed into expansion in domestic and foreign markets, then it can lead to an "unacceptable release of employment".

According to SuperJob forecasts, 10 million of the most low-skilled Russians will lose their jobs in 10 years. To overcome this, it is necessary to implement retraining programs, relocation and build 100-120 million square meters of housing per year. We need a serious restructuring of the entire education system, starting with kindergartens and primary schools [4].

Interdisciplinary educational programs related to "robot communication", the interaction of the human mind with the "intelligence" of the robot will be required (specialists in the field of design, maintenance of robots, virtual reality designers, lawyers for resolving disputes related to the activities of robots, psychologists,digital scientists, data Scientist, etc.).

At the same time, the threat of unemployment growth due to the development of the digital economy can be partially neutralized by other factors. Namely: the shortage of labor in other industries; the emergence of new professions and activities; the demand for specialists in the expanding domestic IT sector, which will require scientists, engineers, programmers, operators, Adjusters and highly skilled workers-which the country lost in the 1990’s during the restructuring); state subsidies for retraining programs, reorientation of the education system in accordance with the emerging new professions. However, the emergence of new unemployed will lead to some reduction in demand and will be an obstacle to increasing production. In addition, the robotization of production will lead to the overflow of capital from the real to the financial sector, which generates the appearance of financial pyramids and bubbles [10].

Russia, along with other countries, is involved in the "construction" of a digital civilization, which has significant advantages, but also exacerbates the risks associated with the growth of the "digital divide" between citizens and business within countries, and between countries, and the invasion of citizens’ privacy. The emergence of private cross-border management systems for economic, social and political processes affecting the national interests of States and their associations is also possible [11]. Subjects can protect their own interests using new technologies and smart contracts. However, the system of legal regulation is already being improved in connection with the widespread use of new technological opportunities in all spheres of society.

The solution to these problems is seen in the creation of a new type of innovative inter-industry clusters. The first experience of creating such structures is available in Moscow, where the formation of a new type of innovation and production cluster (IPC) is taking place, which moves away from the industry principle and will be the first Russian inter-industry supercluster that will unite IT companies, business incubators, technology parks and academic institutions on a single IT platform.

From 2019, Russia is expected to start reforming the technoparks and clusters system, based on the needs of Industry 4.0. By 2025, the government plans to launch at least 10 clusters and 15 technoparks operating on the basis of digital platforms.

IV. Conclusion

Industry 4.0 will change technology and the organization of production. Its associated tools enable; the unification of organizations’ human capital, the consolidated management of all stages of the product life cycle in a single information space; and, the consolidation of the efforts of literally all industries to implement a technological breakthrough.

State support for the creation of technological platforms and innovative clusters promises to stimulate the introduction of "smart industries". These technological complexes can create the foundation for an integrated information space that provides support for the implementation of business processes throughout the product life cycle, from market research to the disposal of equipment and finished products. Innovation clusters are based on inter-sectoral relations and the unification of science, education and production. It is this interdisciplinary approach that creates the conditions for the implementation of Industry 4.0.

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