

Scientific and technical development of Russia's high-tech companies in the context of introducing the conception "Industry 4.0" and the digital economy development

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Abstract. The research paper focuses on a complex study of scientific and technological development of high-tech companies of the Russian Federation in the context of introducing the conception "INDUSTRY 4.0", which involves six main phases: 1) Computerisation; 2) Connectivity; 3) Visibility; 4) Transparency; 5) Predictive capacity; 6) Adaptability. The article describes external factors – with the help of such marketing tool as the STEP-analysis – that have an impact on scientific and technological development of Russia's high-tech companies in the context of introducing the digital economy and conception "INDUSTRY 4.0." The authors of the research paper present the scheme for cooperation components of scientific and technological development of industrial enterprises in the Russian Federation which includes such important aspects as the forming process a progressive technological base; development methods of objective assessment for the technical development prospects; using of artificial intelligence and neural network; making more efficient use of industrial enterprises; searching for new energy sources and their using; accelerate biotechnologies; research on the new breakthrough technologies; application of achievements in science and technology; development of new design solutions; development of aerospace industry in the military-industrial complex; development of new kinds of materials and their using in the production process and others. The authors present data indicating the number of organizations which perform research and developments. The authors' research perspectives present practical aspects of scientific and technical development of military-industrial complex as a whole and aerospace industry of the Russian Federation in general.

1 Introduction

The modern productive-economic system, functioning on the territory of the Russian Federation, aims to implement a digital transformation and adaptation to technologies in

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collaboration with the environment. Research shows that scientific and technological progress (which does not stand) still presents new challenges dictated by active promotion of the concept «INDUSTRIE 4.0». The purpose of the research is to present the STEP-analysis and the scheme of cooperation components of scientific and technological development of high-tech companies of the Russian Federation on the basis of the conducted studies. The object of the research is the advanced industrial enterprises, which include high-tech companies. The subject of the research is the scientific and technical development of industrial enterprises in the context of adaptation of the concept "INDUSTRY 4.0" and the development of the digital economy in the Russian Federation.

2 Materials and methods

The study is based on a general scientific methodology that applies a systematic approach to the solution of the problem of introducing the concept of "INDUSTRY 4.0" into the activities of high-tech companies of the Russian Federation. It is worthwhile to note that recently, scientists around the world are actively engaged in the problems of introducing the digital economy and the concept of "INDUSTRY 4.0" into the activities of industrial enterprises. Among the active supporters of the concept should be noted the following scientists: A. Cerezo-Narváez, M. Otero-Mateo, F. Rodríguez-Peccei, A. Pastor-Fernández [1]; A. A. Gohar, A. Cashman [2]; B. Chen, J. Wan, L. Shu, P. Li, M. Mukherjee, B. Yin [3]; C. F. Chien, T. W. Liao, R. Dou [4]; D. Mourtzis, S. Fotia, N. Boli, P. Pittaro [5]; de A. B. L. Sousa Jabbour, C. J. C. Jabbour, C. Foropon, M. G. Filho [6]; G. Reischauer [7]; H. G. Lee, J. H. Huh [8]; J. Horrillo-Tello, J. Triado-Aymerich [9]; J.A. Gobbo, C.M. Junior, Busso, S. C. O. Gobbo, H. Carreão [10]; J.M. Müller, O. Buliga, K. I. Voigt [11]; L. Feng, X. Zhang, K. Zhou [12]; M. Faheem, V. C. Gungor [13]; M. Khakifirooz, C. F. Chien, Y. J. Chen [14]; M. Lewin, S. Voigtlander, A. Fay [15]; P. Dallasega, E. Rauch, C. Linder [16]; P. Macurová, L. Ludvík, M. Žwakova [17]; P. Schneider [18]; S. Luthra, S. K. Mangla [19]; S.S. Kamble, A. Gunasekaran, S. A. Gawankar [20]; T. K. Sung [21]; U. Topal, M. C. Cens [22]; V. C. Coffey [23]; W. Bodrow [24]; Y. Wang, H. S. Ma, J. H. Yang, K. S. Wang [25]; Y. Young, P. Loebach, K. Korinek [26]; Z. Li, Y. Wang, K.-S. Wang [27]; Z. Nie, P. Wang, P. Zeng, H. Yu [28]. Earlier the authors of the research paper studied the impact of digitalization and industrialization on asset planning and scientific and technological development of the production and economic system of the Russian Federation [29], and also carried out long-term planning and scientific and technological development of the Russian economy in the field of industrial markets under digitalization conditions [30].

3 Equations and mathematics

The experience of implementing the concept "Industry 4.0" is not a new world breakthrough, so Germany government within the framework of the "High-tech Strategy-2020" has identified ten projects of the future, which expire in two years. Since the world powers have already implemented similar projects, the Russian Federation should take into account the positive experience of foreign countries. According to German researchers, the industrial enterprises of the Russian Federation should go through six stages on the way to the concept of "INDUSTRIE 4.0": 1) Computerisation; 2) Connectivity; 3) Visibility; 4) Transparency; 5) Predictive capacity; 6) Adaptability. Table 1 presents one of the marketing tools, namely the STEP-analysis of the scientific and technological development of industrial enterprises in conditions of digitalization and industrialization of the economy.

Table 1. STEP-analysis of scientific and technical development of industrial enterprises in Russia in conditions of “INDUSTRY 4.0”.

1	<i>Social</i>	3	<i>Economic</i>
1.1	Changes in the organization of production	3.1	Reduction of energy costs
1.2	Improvement of working conditions for employees and employees	3.2	Economical, rational use of material resources
1.3	Organization of new jobs	3.3	Improving the quality of finished products
1.4	Increase in wages of employees and employees	3.4	Efficiency of innovative (scientific and technical) development
2	<i>Technological</i>	4	<i>Political</i>
2.1	Introduction of new technologies in the activities of industrial enterprises	4.1	Inflow of investments
2.2	Improvement of existing technologies	4.2	Leading positions in the market
2.3	The use of breakthrough technologies, including artificial intelligence	4.3	Competitiveness of finished products in the world market
2.4	Use of energy-saving technologies	4.4	Increase in exports of finished products

From the data presented in Table 1, it follows that the most important social factors for Russian companies are: improving the working conditions of employees and employees. With regard to technological factors that affect the development of high-tech companies, it is worthwhile to note the introduction of new and the use of breakthrough technologies, as well as the use of energy-saving technologies. Reduction of energy costs; economical, rational use of material resources; Increasing the efficiency of innovative (scientific and technical) development are economic factors. The main political factors include the inflow of investment; advanced positions in the market; competitiveness of finished products in the world market; increase in exports of finished products. In Figure 1, we present a scheme for the interaction of the components of the scientific and technological development of industrial enterprises in the Russian Federation.

It follows from Figure 1 that the scientific and technological development of industrial enterprises in the Russian Federation includes a number of important components. Table 2 shows the number of organizations performing research and development in the Russian Federation.

Also, Table 2 demonstrates that the largest number of organizations engaged in research and development in 2016 scientific and research organizations - 1673, the second position is occupied by education establishments of higher education - 979.

Table 2. Research and development organizations.

	2014	2015	2016
Total	3604	4175	4032
including:			
scientific and research organizations	1689	1708	1673
design offices	317	322	304
designing and surveying organizations	32	29	26
experimental plants	53	61	62
education establishments of higher education	702	1040	979
industrial organizations with scientific -research and project designing divisions	275	371	363
Other	536	644	625

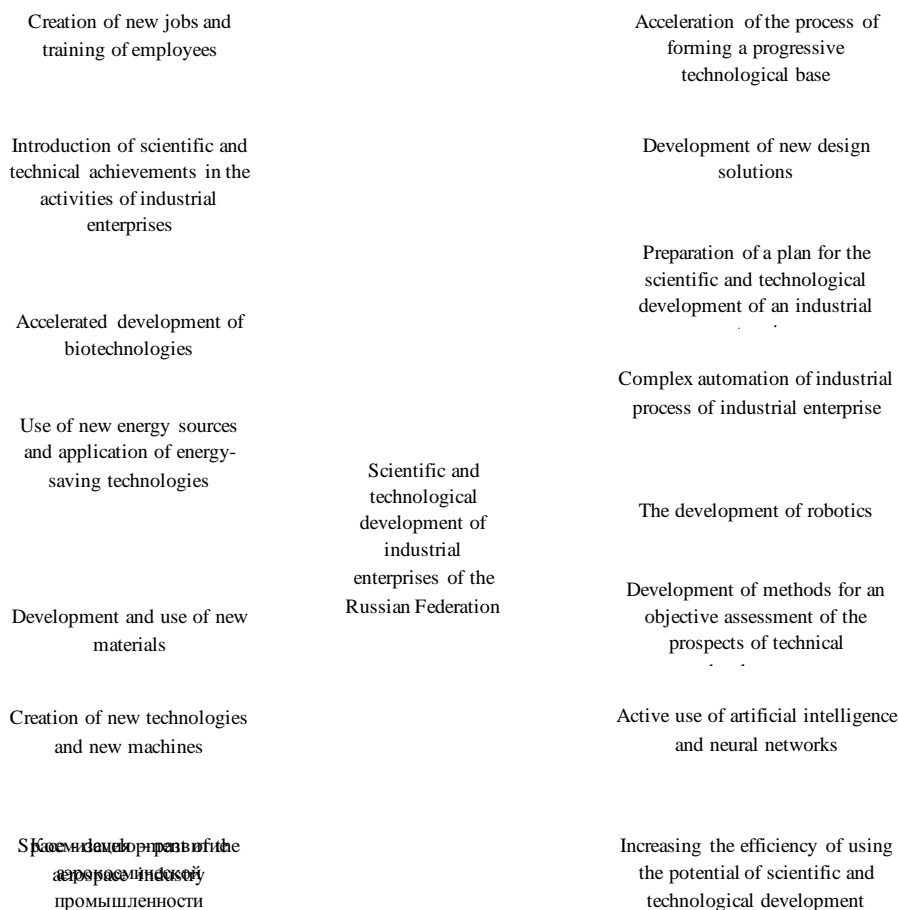


Fig. 1. Scheme of interaction of components of scientific and technological development of industrial enterprises.

4 Conclusion

In conclusion of the study it should be noted that the scientific and technical development of industrial enterprises in Russia in the key of the concept "INDUSTRY 4.0" includes a number of important areas of knowledge, such as robotics, space, biotechnology, automation of production processes, etc. Introduction of high-tech companies in scientific and technological achievements will help domestic enterprises take the leading positions in the world market and produce competitive finished products. Prospects for the authors' research are related to the practical aspects of the scientific and technological development of the defense industry complex in general and the aerospace industry of the Russian Federation in particular.

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