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Digital technologies development factors in the industrial park structures

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***Abstract* — The relevance of the study is due to the need of accelerating the digitalization of Russian industry. According to foreign authors, sectoral and territorial imbalances in the level of digitalization are one of the main reasons for the slowdown in economic growth. On the other hand, the challenges facing the modern economy of Russia are directly related to the search for new forms of organization and management of enterprises in order to increase the indicators of socio-economic development of both individual territories and the country as a whole. The solution of these problems is carried out in different directions, including through the creation and development of industrial park structures - integration entities that form additional effects for a wide range of stakeholders.**

In this regard, the identification of the factors of the digital technologies development for residents of industrial park structures will allow us to form effective strategies for the industries development.

The purpose of the article is to determine the influence of individual development factors on the degree of use of digital technologies in Russian industry and industrial park structures in particular.

As a research method, we used paired linear regression models, the resulting indicators of which reflect the digitalization indicators for residents of industrial park structures: Using of special design software; Using of special software for managing automated production and / or individual technical means and technological processes, Using of CRM, ERP, CSRP, BPM, SCM - systems. The choice of factor indicators is determined by the existing base of statistical observations and includes The availability of Internet access infrastructure, The availability of qualified personnel and The volume of enterprise investment in information technologies.

The results of the studies show that the greatest impact on the introduction of digital technologies has a staffing of residents of industrial park structures with relevant specialists in the field of information technologies. At the same time, the remaining factors investigated in this article are not significant enough.

Keywords — digitalization, residents of industrial park structures, digital technology development factors

I. INTRODUCTION

The transition from analogue to digital technologies began in the 1950s. Currently, technological developments have laid the foundation for automation and digitalization of a wide range of corporate and social processes. Various objects are displayed in digital format, processed, stored and transmitted at a much higher speed, which leads to the transformation of business models. A large number of production, financial, commercial operations, advertising, public administration processes, distribution channels, etc., undergo digital modification. The development of digital technologies has far-reaching consequences for the industrial sector of the economy, changing production processes and requirements for human resources. As noted in [1], as a result of digitalization, such phenomena as outsourcing, deterritorialization of production, the emergence of virtual, amorphous value chains have appeared. For example, digital platform technology, chipping, and bar coding have taken center stage in the control and management of workflows.

Active digitalization encourages the search for effective methods for assessing this phenomenon and the factors that determine the course of this process. In [2], [3], large-scale studies devoted to identifying and explaining the causes of imbalances in the use of digital technologies for a sample of 142 developed and developing countries. The studies identified the following significant factors:

- The country's GDP is a key factor in digitalization for all groups of countries, while its role is more important for countries with an average level of digitalization;

- A model of digitization of data, which is explained by the authors of the type of country, differences in economic development, as well as socio-demographic and institutional variables;

- Institutional regulation and infrastructure explain the more active introduction of digital technologies in countries with high levels of GDP.

In article [4], in addition to the GDP indicator, the list of digitalization factors includes The level of enrollment in

higher education institutions, The share of urban population and The share of services in GDP. With the exception of the factor of The share of the urban population, which demonstrates the inverse effect on the digitalization level, other factors increase the likelihood that the country will belong to a group with a higher level of use of digital technologies. From the factors listed in this article, The level of enrollment in higher education institutions is most conducive to the development of digital technologies in the country. At the same time, as noted in [5], The number of higher education students is declining, which may form a barrier to the digitalization of the Russian economy.

In [6], [7] factors of digitalization of manufacturing industries are considered in more detail. The authors focus on the modification of service under the influence of digital technology. The Internet of things, cloud technology and digital analytics enable the formation of supporting digital service delivery architectures. The significant factors in the implementation of this process, the authors attribute the availability of qualified workers and the propensity of companies to invest in digitalization processes.

In Russian practice [8], [9] the main factors of digitalization include The provision of the enterprise with equipment with computer numerical control (CNC). In a study conducted by the «RosBusinessConsulting» (RBC) agency [10], it was noted that in Russia, only 14% of plants have such equipment in more than half of all types of machine tools. Researchers recorded the largest number of CNC machines in the aviation industry - almost 30%. About 20% of CNC machine tools were in instrument making, just over 10% were in machine tool building. For comparison: in the automotive industry and heavy engineering, this figure does not reach 10%. At the same time, about 80% of the enterprises surveyed intend to purchase additional machines within three years.

Another condition for digitalization is The availability of an automated planning and accounting system at the enterprise. According to the study, such systems were not installed in 20% of respondents.

For the development of digital infrastructure, according to the authors of the study, it is also important to identify a special employee who will be responsible for this area. However, only 6% of respondents have a director for innovation or the digital economy. In 61% of cases, such a position in the workplace is absent, and another third of the responsibilities are distributed among several posts.

Especially important is the introduction of advanced digitalization technologies for industrial park structures, the number of which has increased significantly in Russia in recent years, including with the active support of the state. Such objects are: technology parks (technoparks), technology transfer centers, industrial parks, business incubators, equipment sharing centers, special economic zones, technopolises, etc.

It should be noted that the traditional methodology of strategic management, based on a wide range of administrative tools, does not allow with a sufficient degree of efficiency to ensure the successful implementation of projects for the creation of industrial park structures.

Most stakeholders of industrial parks structures note that the effectiveness of these facilities is insufficient and requires the use of a new digital management methodology that allows them to actively interact with key stakeholders.

More than a hundred parks that are at the creation stage are faced with problems both of internal coordination of business processes, and in building relations with state and business structures, in building infrastructure, obtaining tax preferences, improving social indicators, etc.

II. Research Methodology

Summarizing the approaches to identifying and researching the factors of introducing digital technologies, three factors can be distinguished in the opinion of authors contributing to the industry digitalization. The following hypotheses, shown in Figure 1, were tested during the study.

Manufacturing Digitalization Indicators	
Using special software for design Using of special software for managing automated production and/or individual technical means and technological processes Using Customer Relationship Management (CRM), Enterprise Resource Planning (ERP), Customer Synchronized Resource Planning (CSRP), Business-Process Management (BPM), Supply Chain Management (SCM) - systems	**H1**: The level of digitalization indicators is related to the availability of Internet access infrastructure **H2**:The level of digitalization indicators is related to staffing by qualified personnel **H3**: The level of digitalization indicators is related to the volume of enterprise investment in information technologies

Fig. 1. Hypotheses verified by the authors in order to assess individual factors that determine the level of digitalization of industrial park structures

To test hypotheses, paired regression models are used, in which the resulting indicators are indexes characterizing the level of digitalization of industrial park structures. The following factor indicators are used: The availability of Internet access infrastructure, The availability of qualified personnel and The volume of industrial park structures residents' investments in information technologies. The research information base included statistical observation data contained in [11], [12], [13], [14].

III. Research Results

To characterize the intensity of the penetration of digital technologies into the economy, let us imagine the share of organizations using digital technologies by type of economic activity in 2017.

TABLE I. ORGANIZATIONS USING SPECIAL SOFTWARE BY TYPE OF ECONOMIC ACTIVITY IN 2017

Type Of Economic Activity	Percentage Of The Total number Of Organizations Using Special Software					
	Electronic Document Management Systems	*Systems for financial settle-ments in electronic form*	*Systems for solving organiza-tional, economic and mana-gerial tasks*	*Systems for providing access to global infor-mation networks*	*CRM, ERP, CSRP, BPM, SCM systems*	*Educa-tional programs*
Average	66,1	54,8	52,4	29,8	17,4	14,2
Business sector	62,3	53,7	52,7	27,5	24,6	15,4
Mining	63,6	55,6	58,7	24	29,3	29,4
Manufacturing	67,7	69,3	66,4	28,9	32,5	16,8
Providing electricity, gas and steam; air conditioning	74,1	63,3	62,6	31,4	24,7	25,2
Water supply; water disposal, organization of waste collection and disposal, pollution elimination activities	59,5	52,3	44,3	24,9	7,6	8,4
Construction	60,1	57,1	51,7	22,4	12,5	10,4
Wholesale and retail trade; repair of motor vehicles, motorcycles	65	52,4	53,7	33,7	43,2	18,5
Transportation and storage	67,8	55,3	61,4	26,1	21,6	27,9
Activities of hotels and catering establishments	60,4	58	50,9	34,1	20,4	12
Information and communications activities	71,3	58	59,1	35,1	28,4	19,3
Real estate activities	42	35,7	32,8	15,3	4,5	4,3
Professional, scientific and technical activities	66,1	57,1	52,1	26,2	14,3	11,2
Administrative activities and related additional services	64,5	55,2	51,5	30	13,4	10,7
Activities financial and insurance	69,7	66,7	66,2	45,7	43	38
Social sphere	74,8	54,8	62,3	33,5	29,4	15,8
Higher education	77,6	76,8	80,1	46,8	24,7	78,6
Health and social work activities	75,7	69,5	61,9	33,4	7,7	11,4
Activities in the field of culture, sports, leisure and entertainment	54	36	35,3	25,4	3,4	6,1
Public administration and military security; social Security	76,2	57,6	52,7	31,9	4,7	9,1

As can be seen from the table 1, more than fifty percent of organizations use only three types of digital technologies: Electronic document management systems – 66.1%, Systems for making financial settlements in electronic form - 54.8%, Systems for solving organizational, economic and managerial tasks - 52.4%.

A very low level compared to foreign organizations is observed in the implementation of CRM, ERP, CSRP, BPM, SCM-systems, namely 17.4%. Therefore, we can conclude about the low rate of digitalization of the Russian economy. Since digital technologies cannot be adapted for use in industry without the presence of CRM, ERP, CSRP, BPM, SCM-systems, it is possible to predict the failure of digitalization in the following areas of activity: Water supply; water disposal, organization of waste collection and disposal, pollution elimination activities, Construction, Transportation and storage. The use of CRM, ERP, CSRP, BPM, SCM systems is 7.6%, 12.5% and 21.6%, respectively. At the same time, in the category of Manufacturing industries, the level of use by organizations of CRM, ERP, CSRP, BPM, SCM - systems is 32.5%, which indicates the presence of digitalization potential.

Table 2 below presents the results of an analysis of the significance of the impact of factors on the indicator of the use of special software for design by residents of industrial park structures.

TABLE II. THE IMPACT OF DIGITALIZATION FACTORS ON THE INDICATOR OF THE USE BY RESIDENTS OF INDUSTRIAL PARK STRUCTURES OF SPECIAL SOFTWARE FOR DESIGN

	Digitalization Factors		
	Factor - availability of Internet access infrastructure	*Factor - the availability of qualified personnel*	*Factor - the volume of enterprise investment in information technologies*
Regression equation	$Y = -7{,}39 - 0{,}19\ X_1$	$Y = 17{,}8+0{,}16\ X_1$	$Y = 9{,}91 + 0{,}0001\ X_1$
Reliability model	reliable	reliable	reliable
The significance of factor X_1	significant	significant	significant
The direction of influence of factor X_1	direct	direct	direct
R_2	0,17	0,38	0,07
The degree of exposure to factors	weak	average	weak

As can be seen from table 2, the studied factors are significant for assessing changes in the resulting indicator, that is, their dynamics to some extent determines the intensity of the use by residents of industrial park structures of special software for design. However, only the factor of qualified personnel demonstrates an average degree of impact on the resulting indicator. Perhaps the low degree of influence of the availability of Internet access infrastructure is due to the sufficient distribution of the network [15], which has ceased to critically affect the introduction of digital technologies. On the other hand, this factor is more significant in the digitalization of consumer behavior processes than in the digitalization of the production process.

Next, in table 3, we consider the impact of digitalization factors on the indicator of the use by residents of industrial park structures of special software for managing automated production and / or individual technical means and technological processes.

TABLE III. THE IMPACT OF DIGITALIZATION FACTORS ON THE INDICATOR OF THE USE BY RESIDENTS OF INDUSTRIAL PARK STRUCTURES OF SPECIAL SOFTWARE FOR MANAGING AUTOMATED PRODUCTION AND / OR INDIVIDUAL TECHNICAL MEANS AND TECHNOLOGICAL PROCESSES

	Digitalization Factors		
	Factor - availability of Internet access infrastructure	***Factor - the availability of qualified personnel***	***Factor - the volume of enterprise investment in information technologies***
Regression equation	$Y = -3{,}71 + 0{,}19\ X_1$	$Y = 19{,}1+1{,}06\ X_1$	$Y = 13{,}75+0{,}001\ X_1$
Reliability model	reliable	reliable	reliable
The significance of factor X_1	significant	significant	significant
The direction of influence of factor X_1	direct	direct	direct
R_2	0,13	0,31	0,018
The degree of exposure to factors	weak	average	weak

As can be seen from the table 3, the availability of Internet access infrastructure and the volume of enterprise investment in information technologies practically do not affect the processes of managing automated production. This disproves the conclusions about the dependence of digitalization on the volume of investment in information technologies presented in [6] and [7], confirms the thesis about the need to increase the availability for residents of industrial park structures with personnel working in the field of information technologies.

Next, we consider the impact of factors on the use by residents of industrial park structures of CRM, ERP, CSRP, BPM, SCM - systems, table 4.

TABLE IV. THE IMPACT OF DIGITALIZATION FACTORS ON THE INDICATOR OF THE USE BY RESIDENTS OF INDUSTRIAL PARK STRUCTURES CRM, ERP, CSRP, BPM, SCM - SYSTEMS

	Digitalization Factors		
	Factor - availability of Internet access infrastructure	***Factor - the availability of qualified personnel***	***Factor - the volume of enterprise investment in information technologies***
Regression equation	$Y = -11{,}6 + 0{,}30\ X_1$	$Y = 21{,}1 + 0{,}17\ X_1$	$Y = 15{,}11 + 6{,}62\ X_1$
Reliability model	reliable	reliable	reliable
The significance of factor X_1	significant	significant	significant
The direction of influence of factor X_1	direct	direct	direct
R_2	0,15	0,27	0,07
The degree of exposure to factors	weak	weak	weak

As can be seen from the table 4, the studied models are reliable and the factors included in them are significant for the indicator of the use by residents of industrial park structures of CRM, ERP, CSRP, BPM, SCM - systems. At the same time, there is a weak effect of all factors on the resulting indicator.

Let's summarize the results obtained, Figure 2.

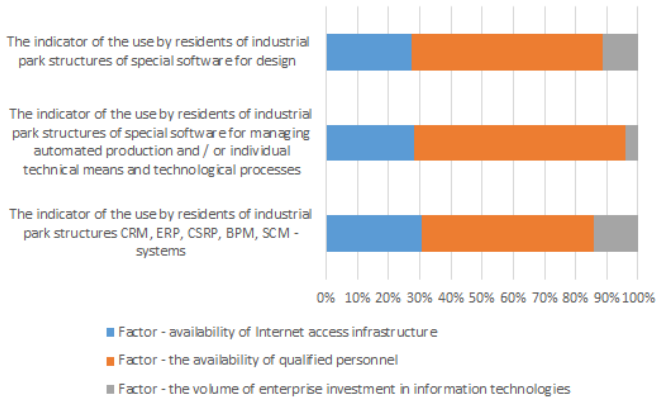

Fig. 2. A comprehensive assessment of the digitalization factors of residents of industrial park structures

A comparative analysis of the impact of factors on the digitalization indicators of residents of industrial park structures shows that the greatest impact on the introduction of digital technologies is provided by the availability of appropriate personnel for enterprises. This conclusion coincides with the results of the study cited in the source [10]. At the same time, the remaining factors investigated in this article are not significant enough.

IV. THE DISCUSSION AND FINDINGS

The study allows us to conclude that the selected factors for analysis have different degrees of influence on the development of digitalization of residents of industrial park structures.

The list of factors selected for analysis is obviously not exhaustive. The development and effective implementation of digital technologies can be influenced by factors of various nature, including the level of GRP per capita, the number of people with higher education [16], and the share of people with higher education. In addition, there is a number of studies substantiating the fact that more affluent countries and more educated regions have advantages in the development of a digital economy that are long-term [17].

Therefore, summing up the results of the study, it can be stated that the factor of staffing with competencies in the field of digitalization identified in the course of this study is key, which means the need for special attention of the state when forming a state order for training specialists in the field of digital technologies.

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