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Пути решения задач цифровой трансформации в отдельных отраслях экономики на современном этапе

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Аннотация. *В статье представлено описание метода оценки современного состояния развития информационно-коммуникационных технологий в России и их влияние на становление национального технологического приоритета. Исследование построено на анализе статистических данных приведенных в материалах Росстата за период 2016-2022 годы. В качестве основных параметров исследования развития творческого потенциала, в первую очередь работников научного сообщества, выбраны: целевые функции Y1 –количество публикаций в высокорейтинговых журналах (индексируемых в базе «Скопус») и Y2 – количество поданных заявок для защиты права интеллектуальной собственности на созданные технические решения. В качестве варьируемых параметров, обуславливающих значения целевых функций, выбирали: X1 –инвестиции в основной капитал, млрд. руб.; X2 - среднесписочная численность работников, тыс. чел.; X3 –уровень инновационной активности организаций, %; X4 –затраты на исследования и разработки в организациях сектора ИКТ, млн.руб. В ходе работы применены современные пакеты прикладных программ, с помощью которых обнаружены корреляционные связи и регрессионные зависимости между исследованными параметрами и представлена их графическая интерпретация для содержательного анализа происходящих в области исследований процессов. По итогам выполненного анализа авторами выявлена остро назревшая необходимость реформирования системы инвестирования в развитие информационно-коммуникационных технологий, которая в ходе практики ее использования в 2016-2022 годах, несмотря на устойчивый рост публикаций в высокорейтинговых журналах, год от года постепенно снижала количество подачи заявок на объекты интеллектуальной собственности, что приводило к торможению процессов становления национального технологического приоритета. По итогам выполненного анализа авторами выявлена остро назревшая необходимость реформирования системы инвестирования в развитие информационно-коммуникационных технологий, которая в ходе практики ее использования в 2016-2022 годах, несмотря на устойчивый рост публикаций в высокорейтинговых журналах, год от года постепенно снижала количество подачи заявок на объекты интеллектуальной собственности, что приводило к торможению процессов становления национального технологического приоритета.*

Ключевые слова: цифровая трансформация, информационно-коммуникационные технологии, система инвестирования, национальный технологический приоритет

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Research article

The ways to solve digital problems transformations in certain sectors of the economy at the present stage

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Abstract. *The article describes a method for assessing the current state of development of information and communication technologies in Russia and their impact on the formation of a national technological priority. The study is based on the analysis of statistical data provided in the materials of Rosstat for the period 2016-2022. As the main parameters of the study of the development of creative potential, primarily of employees of the scientific community, the following target functions were selected: Y1 – the number of publications in highly rated journals (indexed in the Scopus database) and Y2 – the number of applications submitted to protect intellectual property rights for created technical solutions. The following parameters were chosen as variable parameters determining the values of target functions: X1 - investments in fixed assets, billion rubles; X2 - the average number of employees, thousand people; X3 – the level of innovative activity of organizations, %; X4 –research and development costs in ICT sector organizations, million rubles. In the course of the work, modern application software packages were used, with the help of which correlations and regression dependencies between the studied parameters were discovered and their graphical interpretation was presented for a meaningful analysis of the processes taking place in the field of research. Based on the results of the analysis, the authors identified an urgent need to reform the investment system in the development of information and communication technologies, which, during the practice of its use in 2016-2022, despite the steady growth of publications in highly rated journals, gradually reduced the number of applications for intellectual property objects from year to year, which led to a slowdown in the processes of becoming a national technological priority.*

Keywords: digital transformation, information and communication technologies, investment system, national technological priority

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Introduction. The main document setting the vector of the current stage of improving digitalization systems in various spheres of society is the National Program "Digital Economy of the Russian Federation", approved by the minutes of the meeting of the Presidium of the Council under the President of the Russian Federation for Strategic Development and National Projects dated June 4, 2019, No. 7. In development of the provisions of the program, "Methodological recommendations for the digital transformation of state corporations and companies with state participation" have been developed, Moscow, 2019.

This document provides for the following measures to advance the implementation of the planned tasks "...the direction of digital transformation: creation and development of new business models; formation of a new approach to data management; digital modeling, implementation of digital technologies and platform solutions; creation of a digital environment" [1].

Successful solution of the stated tasks is impossible without mobilization of efforts of various branches of industry. Achievements that can form the basis of new breakthrough solutions can be obtained on the basis of analysis of the current state of this sphere.

An idea of the current advantages and disadvantages, and most importantly, ways to overcome emerging difficulties, are presented in the data collection of the Statistical Review of the Higher School of Economics for 2024 [1].

Materials and research methods. Within the framework of the conducted research on the specified indicators, an analysis of publication activity in the field of information and communication technologies (ICT), as well as the activity of their use in patent and invention activities, was conducted. Both selected parameters, from our point of view, fairly objectively assess the effectiveness of using innovative scientific developments. Taking into account the above, the following were included as target functions reflecting the creative potential accumulated to date:

Y 1 – number of publications in high-ranking journals (indexed in the Scopus database);

Y 2 – the number of applications submitted to protect intellectual property rights to created technical solutions.

The following were chosen as variable parameters that determine the values of the objective functions:

X1 – investments in fixed capital, billion rubles;

X2 - average number of employees, thousand people;

X3 – level of innovative activity of organizations, %;

X4 – expenses on research and development in ICT sector organizations, million rubles.

Based on the results presented in the specified statistical collection [2], the following table was formed (Table 1):

Table 1 – Statistical data on the field of information and communication technologies (ICT) for 2016-2022

Years	**Investments billion rubles**	**Number of employees, thousand people**	**Level of innovation activity, %**	**ICT costs, thousand rubles**	**Scopus**	**Patents**
	x1	x2	x3	x4	y1	y2
2016	461	1245	11	34032,5	8755	1978
2017	474	1220	15.9	25309,1	11511	2270
2018	604	1191	12.2	24440,1	13388	2062
2019	741	1203	12.1	22663,7	17293	2706
2020	832	1240	13.5	34801,1	18695	2489
2021	938	1285	14.4	31000,9	18221	2161
2022	1043	1357	13.9	36996,1	16423	2203

The obtained data were subjected to correlation analysis (Table 2)

Table 2. Correlation matrix of statistical data

	X1		**X2**	***X3***	***X4***	**Y1**	**Y2**
X1	1						
X2	0.723575		1				
X3	0.230844		0.276385	1			
X4	0.46816		0.784244	-0.00537	1		
Y1	**0.842214**		0.272981	0.253514	0.109771	1	
Y2	**0.257877**		-0.23174	0.104287	-0.31732	0.616842	1

The analysis of the table formed as a result of calculating the mutual correlation coefficients of statistical indicators indicates the correctness of the set of variable parameters and the selected response functions. At the same time, it is possible to conditionally distinguish the

"optimistic" (bold text) and "pessimistic" (normal underlined) scenarios of the situation development, respectively, for changes in investment structures (X1) and research and development costs in ICT sector organizations (X4).

Using the regression analysis apparatus, we obtained the following polynomial (algebraic) equations and their graphs.

1) $Y1(X1) = 28781.095 - 151.56768x + 0.35426798x^2 - 0.00027771655x^3$

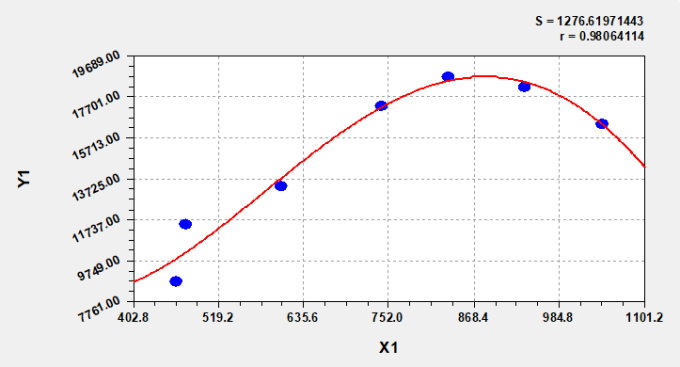

Figure 1 – Change in the number of publications (Y1) from investments in fixed assets (X1)

2) $Y1(X4) = 4710245.1 - 643.19431x + 0.032701832x^2 - 7.3162898x^3$

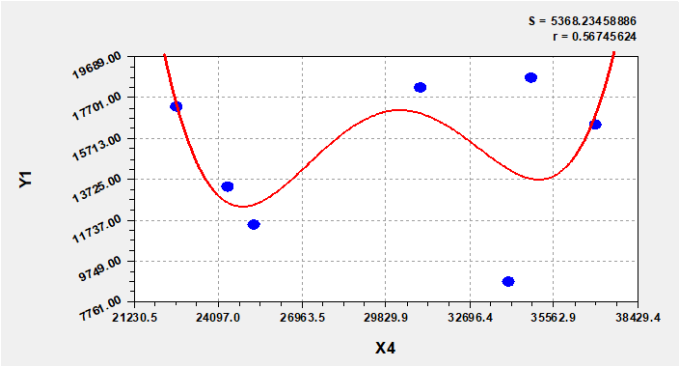

Figure 2 – Change in the number of publications (Y1) from research and development costs (X4)

3) $Y2(X1) = 60451.234 - 341.1816x + 0.72142675x^2 - 0.00065372776x^3$

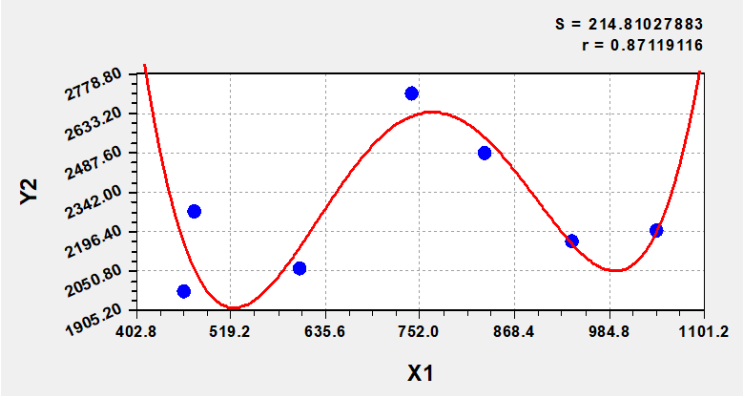

Figure 3 – Change in the number of patent applications (Y2) from investments in fixed assets (X1)

4) $Y2(X4) = 112966.85 - 13.649557x + 0.00062334112x^2 - 1.2526783x^3$

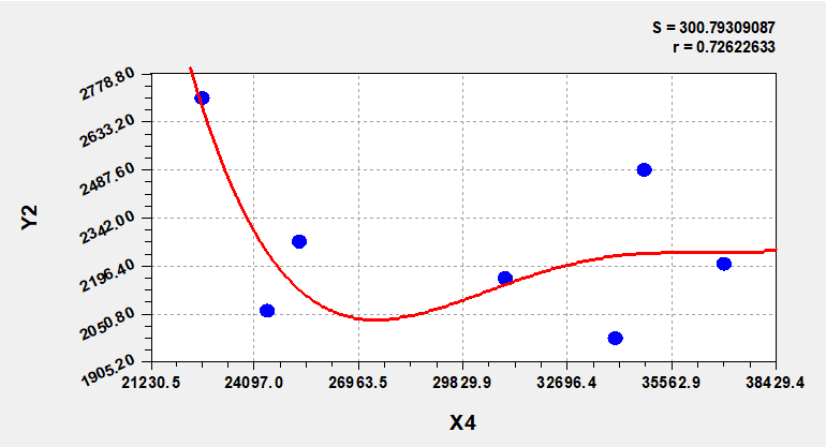

Figure 4 – Change in the number of patent applications (Y2) from research and development costs (X4)

Research results and their discussion. The constructed graphs make it necessary to identify the joint action of the variable factors (X1) and (X2) on the target functions Y 1 and Y 2.

Table 3 – Statistical data processing for X1 and X4

x1	x4	X1^2	x4^2	x1*x4	y1	y2
461	34032,5	212521	1.16E+09	15688983	8755	1978
474	25309,1	224676	6.41E+08	11996513	11511	2270
604	24440,1	364816	5.97E+08	14761820	13388	2062
741	22663,7	549081	5.14E+08	16793802	17293	2706
832	34801,1	692224	1.21E+09	28954515	18695	2489
938	31000,9	879844	9.61E+08	29078844	18221	2161
1043	36996,1	1087849	1.37E+09	38586932	16423	2203

Limit values

461	22663,7	min
1043	36996,1	Max

Y1

0.000478069	-1,96726E-05	-0.054531	0.815193	79,347086	-28469,86
0.001065065	4,62694E-05	0.031212	2,598315	37,896712	39233,71
0.96089246	1823,324606	#N/A	#N/A	#N/A	#N/A
4,914103371	1	#N/A	#N/A	#N/A	#N/A
81684993,38	3324512,62	#N/A	#N/A	#N/A	#N/A

Y2

-6,35916E-06	5,85101E-06	-0.003681	-0.348033	5,8300383	5287,895
0.000227078	9,86492E-06	0.006655	0.553976	8,0798034	8364,859
0.605315377	388,7435975	#N/A	#N/A	#N/A	#N/A
0.306733702	1	#N/A	#N/A	#N/A	#N/A
231770,4154	151121,5846	#N/A	#N/A	#N/A	#N/A

It seems that the most informative graphical analysis of these groups of equations is performed using the Mathcad application software package in the form of level surfaces of response functions such as Y 1 (X 1, X 4) and Y 2 (X 1, X 4) [3].

For example, a graphical representation of the level lines of these equations allows us to obtain areas that describe preferred investment development options (Fig. 5).

$y1(x1, x4) := -28469.9 + 79.3x1 + 0.8x1^2 - 0.1x4$

$y2(x1, x4) := 5287.9 + 5.8x1 - 0.3x1^2$

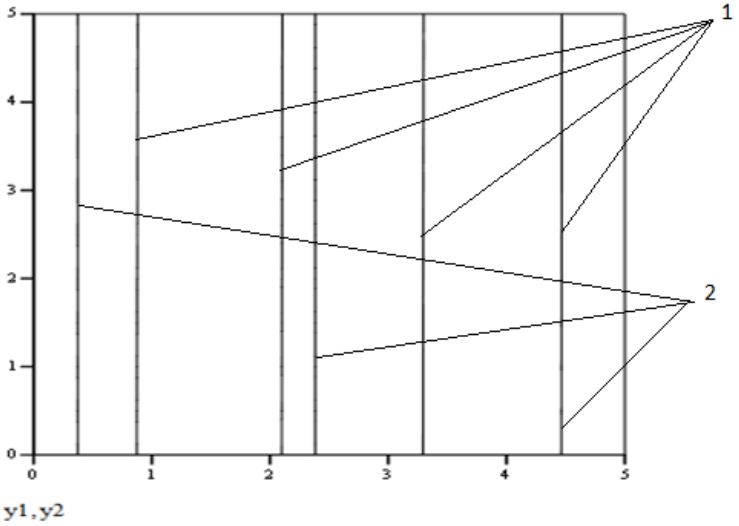

Figure 5 – The nature of changes in the effectiveness of ICT from X1- investments and X4- research costs: (1-Scopus articles, 2-patents)

Conclusion. The graphical interpretation of the results of the mathematical and statistical analysis of the data [2] on the state of ICT development for the period 2016-2022, presented in the form of response surface sections, indicates the need to take urgent measures to transform it. If the response surface sections (1) indicate a slow but constant trend towards an increase in the level of domestic scientific publications (Y 1), then the response surface sections (2) indicate an urgent need to reform the system of investment in ICT development, which, almost year after year, gradually reduces the frequency of filing applications for intellectual property objects, i.e., achieving technological priority. These conclusions are fully consistent with the strategic priorities of scientific and technological development designated by the collegial body under the President and, most importantly, the financial support measures planned for the future.

In expanded form, Russian President V.V. Putin stated at the St. Petersburg Economic Forum on June 7, 2024 that "...The fifth structural change is a real digital platform revolution. In its current conditions, labor productivity is directly related to digitalization, artificial intelligence technologies. By 2030, Russia will have to form digital platforms in all key sectors of the economy and the social sphere. These tasks will be solved within the framework of the new national project "Data Economy"."

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