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Model of State Support for The Digital Transformation of The Manufacturing Industry in Russian Regions

Tanina Anna[1], Ivanova Marina[1], Kulkaev Grigory [1*], Tanin Evgenii[1]

[1]*Peter the Great St. Petersburg Polytechnic University, St. Petersburg, Russia, St. Petersburg, Polytechnicheskaya, 29, 195251, Russia*

Abstract. The digitalization of industrial enterprises has an impact on the development of Russian regions. One of the factors for increasing the efficiency of the digital transformation of the industry is government support. The issues of the impact of state support on the digital transformation of industry in the context of regional development have not been fully studied. The authors' aim was to study the relationship between federal and regional measures to support the digitalization of industrial enterprises and regional development. The subject of the study is the transformation of the digital industry. The authors used correlation and regression analysis, and calculations showed a significant correlation between digitalization and the development of the manufacturing industry. The impact of digitalization on this industry was further investigated using the example of the regions of the Northwestern Federal District. The analysis allowed us to identify three groups of regions, depending on the correspondence of the level of digitalization in the region and the balanced financial result of manufacturing enterprises. An analysis of the digitalization support was also carried out. It was concluded that the achieved level of digitalization of the region and the digital transformation of their industry are provided by federal support measures (mainly financial). In these regions, there is a duplication of federal support instruments, a discrepancy between the measures used and the needs of enterprises in the region. The support measures used do not fully consider the regional specifics of industrial development, and the peculiarities of the Russian Federation as a federal state. Given the results of the study, the authors propose an updated model of state support for the digital transformation of the industry, eliminating the listed problems while maintaining a common strategic approach.

Keywords: Digitalization; Digital transformation; Government support model; Manufacturing industry; State support measures

1. Introduction

The introduction of the principles of Industry 4.0 and the implementation of sustainable development goals in the global economy required changes in approaches to the industrial development of Russian regions. It should be noted that the digitalization of production can have significant differences depending on the country, industry, or the chosen digital transformation strategy (Rodionov et al., 2022; Babkin et al., 2021a; Babkin et al., 2021b; Burova et al., 2021; Tereshko et al. 2021;Tanina et al., 2020).

*Corresponding author's email: kulkaev_g@spbstu.ru, Tel.: +7-958-174-71-75
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The questions about the degree of influence of digital technologies on regional development, the positive correlation between the development of the digital economy, and the productivity of enterprises are debatable (Krakovskaya & Korokoshko, 2021). In one work (Huang et al., 2022) a study was made onthe development of the digital economy in increasing the productivity of enterprises in the region.

Other studies show links between digitalization use and innovation activity, and between innovation and productivity growth (Gaglio et al., 2022). Separate studies show the dependence of key indicators of digitalization on the marginal income of an enterprise, and offer a comprehensive assessment of the level of digitalization of industrial enterprises (Abushova et al., 2022; Ershova et al., 2022). It is necessary to assess the barriers to the digital transformation of enterprises (Borovkov et al., 2021).

A significant role in improving the regional digital infrastructure is played by the authorities, which determine the main directions for supporting the digitalization of individual industries and enterprises (Tanina et al., 2022; Ivanova & Putintseva, 2020). Research shows that government programs to support digitalization are most effective when they take into account the types of digital technologies and their availability for various enterprises (Gaglio et al., 2022; Małkowska et al., 2021; Bessonova & Battalov, 2020).

Russian authors address problems of assessing the digital maturity of organizations, taking into account regional characteristics (Chursin & Kokuytseva, 2022; Krakovskaya & Korokoshko, 2021). An important success factor is the digitalization of public services themselves, including measures to support digital transformation. But not all government support measures show their effectiveness, which requires the use of different approaches depending on the characteristics of enterprises (Endrődi-Kovács & Stukovszky, 2022; Mirolyubova & Voronchikhina, 2022).

In our opinion, the digital transformation strategy of the industry should consider national and other territorial differences, including when choosing measures to support digitalization by the state to achieve sustainable development goals. According to the results of the study of sources, it can be seen that there is a gap in assessing the effectiveness of state support for digital transformation, taking into account the specifics of individual industries, regions, and countries. As part of this study, the authors set themselves the task of assessing the effectiveness of state support measures for the digitalization of industry in Russia (using the example of a group of regions included in the Northwestern Federal District). The authors propose to consider the specifics of the Russian Federation as a country with a federal state system and take these specifics into account when forming a model of state support for the digital transformation of the industry.

2. Methodology

The authors propose to conduct a correlation and regression analysis to identify the relationship between digitalization indices and the economic performance of industrial enterprises in Russia. First of all, the paper proposes to determine which of the Russian industries has experienced the greater impact from digitalization based on international and federal integral indices. For a more detailed analysis, the impact of digitalization on the selected industries will be considered based on regional indicators. After identifying the most influential factor, a regression analysis will be carried out and a regression equation will be compiled to analyze the effectiveness of state support measures for the digitalization of industry in Russia.

2.1. Assessing the impact of digitalization on Russian industries

At this stage of the study, the authors propose to conduct a correlation analysis to assess the impact of digital interactions and transformations on labor productivity in the main sectors of Russian industry, since high labor productivity values improve the quality of the final product, the stability of the enterprise, and its competitiveness, etc. (Novotna, 2017). For calculations, it is proposed to use the statistical data of the Global Connectivity Index - GCI and labor productivity indices by industry (mining, manufacturing, energy production). For analysis, the authors propose to consider a time interval of 5 years with a step equal to 1 year from 2015 to 2020. The results of the correlation analysis are shown in Table 1. When performing these calculations, the Multiple R is equal to 0.91, and R^2 is equal to 0.83. That is to say, the initial data show a strong dependence, so the results obtained can be trusted.

Table 1 The results of a correlation analysis of the relationship between the impact of digital interactions and transformations on labor productivity in the Russian industry (compiled by the authors)

	GCI	Labor productivity in mining	Labor productivity in the manufacturing industry	Labor productivity in the energy sector
GCI	1,00	-0,43	**0,87**	0,14
Labor productivity in mining	-0,4	1,00	-0,17	0,31
Labor productivity in the manufacturing industry	0,87	-0,17	1,00	0,26
Labor productivity in the energy sector	0,14	0,31	0,26	1,00

Thus, Table 1 shows that digitalization in Russia mainly affects the manufacturing industry (correlation index 0.87).

2.2. The impact of digitalization on the manufacturing industry at the regional level

Based on this, it is proposed to consider the impact of digitalization indicators on the manufacturing industry using the example of the Northwestern Federal District of Russia. The Northwestern Federal District plays an important role in the economic development of the entire country (Shkiperova & Kurilo, 2021). The regions of this federal district are different in their socio-economic and financial situation, in the types of manufacturing industry, and the level of development of the industry as a whole, which makes the analysis comprehensive.

For calculations based on the proposed state strategic documents indicators, the authors have selected the following indicators, which are necessary to simplify further illustration of the calculation results, are proposed to be designated: X1 – Use of digital technologies in organizations, %; X2 –Use of broadband Internet access in organizations, %; X3 – Use of the Internet by the population, %; X4 – Number of personal computers per 100 employees, pcs; X5 – Use of electronic document management in organizations,%; X6 – Index of manufacturing production; X7 – Investments in fixed capital in the manufacturing industry per capita, thousand rubles; X8 – The average annual number of employees in the manufacturing industry, thousand people; X9 – Number of manufacturing enterprises and organizations, thousand; X10 – Balanced financial result of manufacturing enterprises, billion rubles. These indicators were highlighted by the authors, as they fully reflect the dynamics of the areas under study, and statistical data are published officially by government authorities. For analysis, the authors propose to consider the statistical data of the above indicators for the Northwestern Federal District of Russia over five years with a

step of 1 year from 2015 to 2020. The results of the correlation analysis are presented in Table 2.

Table 2 Results of a correlation analysis of the impact of the development of information and communication technologies in the region on the economic performance of manufacturing enterprises in the Northwestern Federal District (compiled by the authors)

	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10
X1	1,00	0,98	-0,63	0,21	-0,62	0,41	-0,41	0,53	0,66	-0,66
X2	0,98	1,00	-0,49	0,16	-0,51	0,53	-0,27	0,63	0,52	-0,53
X3	-0,63	-0,49	1,00	-0,32	0,89	0,25	0,87	0,09	-0,95	0,96
X4	0,21	0,16	-0,32	1,00	0,12	0,44	-0,19	-0,02	0,30	-0,31
X5	-0,62	-0,51	0,89	0,12	1,00	0,34	0,79	-0,10	-0,80	0,86
X6	0,41	0,53	0,25	0,44	0,34	1,00	0,44	0,78	-0,28	0,21
X7	-0,41	-0,27	0,87	-0,19	0,79	0,44	1,00	0,24	-0,86	0,94
X8	0,53	0,63	0,09	-0,02	-0,10	0,78	0,24	1,00	-0,21	0,04
X9	0,66	0,52	-0,95	0,30	-0,80	-0,28	-0,86	-0,21	1,00	-0,94
X10	-0,66	-0,53	0,96	-0,31	0,86	0,21	0,94	0,04	-0,94	1,00

The results obtained in Table 2 show a direct dependence of indicators of digitalization on the following: indicators of investment in fixed assets in the manufacturing industry per capita, the number of enterprises and organizations in the manufacturing industry, and the balanced financial result of manufacturing enterprises. Meanwhile the use of the Internet by the population and the use of electronic document management in organizations has a large degree of influence.

2.3. Regression analysis of industry digitalization in the regions of the Northwestern Federal District

The authors propose to form a statistical base for 2020 of the regions of the Northwestern Federal District, according to the digitalization indicators indicated in the work, and the balanced financial result of manufacturing enterprises (resulting factor, Y), as an indicator having the highest values of dependency coefficients. Based on this statistical base, it will be possible to derive a regression equation that will display the calculated value of the resulting factor, which can be compared with the actual one to assess measures of state support for the digitalization of industry. For an array of statistical data, Multiple R is 0.72, and R^2 is 0.71, indicating a high degree of determination of the selected indicators and the reliability of the information that we will receive in the course of further research.

Thus, based on the data obtained, we can derive the following regression equation:

$$Y = X1 * 7.25 + X2 * (-7.92) + X3 * 8.65 + X4 * 3.23 + X5 * 0.29 - 947.5 \qquad (1)$$

In this model, there is partial multicollinearity, but it is due to the fact that the value of the indicators is calculated in the organization. In this regression model, the multiple R value is 0.74 and R^2 is 0.7. P-values for constants and variables do not exceed 0.043. The probability of accepting the null hypothesis is 0.047. These values indicate the validity of the construction of this model and its statistical significance.

When calculating the Durbin-Watson coefficient, a value of 2.4 was obtained, which indicates a slight negative autocorrelation. Also, using the Broish-Godfrey theorem, the value of the student's criterion was 0.588 (with a critical value of 1.833). This fact allows us to reject the null hypothesis, and to conclude that there is no autocorrelation in the model, which once again confirms the reliability of the constructed regression model.

Applying the White Test, the probability of accepting the null hypothesis (which says that the variables are not significant per squared residuals) was 0.887, which indicates the absence of heterodescatism.

Based on the resulting regression equation, you can get the calculated value of the resulting factor.

Thus, this method of mathematical and statistical analysis made it possible to determine the most significant indicators in the field of industry digitalization. Regression analysis shows the calculated value of this indicator, or in other words, at what level the resulting indicator should be at the current level of development of digitalization.

3. Results and Discussion

For a visual comparison of the calculated and actual values of the resulting factor, consider Figure 1. Thus, Figure 1 compares the actual financial result of manufacturing enterprises in the regions under study and the calculated financial result, that is to say, the value that should hypothetically be reached according to the current development of information technology in the regions.

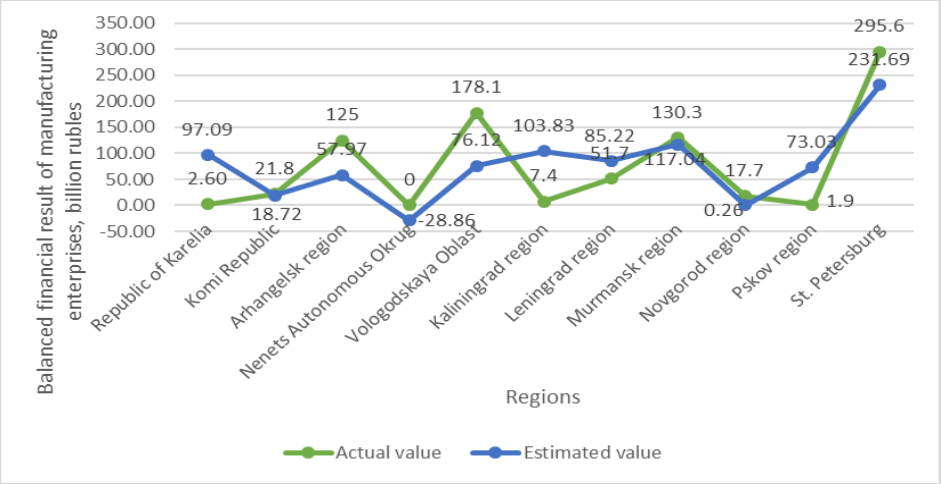

Figure 1 Comparison of calculated and actual values of the resulting factor (compiled by the authors)

Thus, the financial result of manufacturing enterprises in such regions as the Republic of Komi, the Murmansk Oblast, and the Novgorod Oblast corresponds to the achieved level of digitalization. In the regions of the Arkhangelsk Oblast, the Nenets Autonomous Okrug, the Vologda Oblast, and St. Petersburg, the manufacturing industry is ahead of the development of information and communication technologies. In the regions of the Republic of Karelia, the Kaliningrad Oblast, the Leningrad Oblast, and the Pskov Oblast, the manufacturing industry lags behind in development compared to the level of development of digitalization of the regions.

Based on the results of the analysis, it can be concluded that three groups of regions are formed in the Northwestern Federal District:

1. Regions in which the financial result of the manufacturing industry is lower than the overall level of digitalization of the region - this group is characterized by a low level of effectiveness of state support measures for the digital transformation of manufacturing enterprises, since the result of activity is lower than the result of neighboring regions, provided that support measures are equally accessible for all the studied regions.
2. Regions in which the result of the manufacturing industry is higher than the general level of digitalization of the region - this group is characterized by the so-called "super-

efficient" state support measures, since the result of the activity is much higher than the result of neighboring regions, provided that support measures are equally accessible for all the studied regions.

3. Regions in which the result of the manufacturing industry as a whole corresponds to the general level of digitalization of the region - this group is characterized by a sufficient level of effectiveness of state support measures for the digital transformation of industrial enterprises, since the result of the activities of these enterprises corresponds to the plan (calculated value).

Based on this grouping of regions, we will consider a system of tools to support digital transformation, which are implemented in the Russian Federation and in the regions of the North-Western Federal District. The system of state support for the digital transformation of the industry at the federal level is based on the departmental project "Digital Industry". The project primarily aims to develop the regulatory environment in the field of digitalization. In this direction, the state sees the development of state standards in the field of the application of new technologies as the main instrument of support. To date, 6 new standards have been prepared and developed.

The project also provides for the formation of a unified digital environment for the digital transformation process. Within this area of state support, the state information system of industry (GISP) has been created and is functioning. GISP was developed as a digital platform for interaction between authorities and enterprises, building digital processes of cooperation and production chains, providing services for investing in industry, services for supporting the creation and development of the production of industrial enterprises, selecting a set of state support measures, obtaining them and monitoring the achievement of project performance indicators, services for providing production and promotion of industrial products in the domestic market, foreign markets, increasing export volumes, services for analyzing and forecasting the development of production based on objective statistical data. To date, GISP provides in one form or another all the listed services for enterprises of all regions, industries and forms of ownership. The portal also implements the “Digital Passport of the Enterprise” tool - a standardized assessment of the levels of digitalization of a particular enterprise and the possibility of offering relevant IT solutions for implementation.

Another support tool implemented both at the federal and regional levels is debt financing of digitalization projects. At the federal level, this tool is implemented by the Industry Development Fund as part of the Industry Transformation program. Enterprises are provided with loan financing for specific digitalization projects in the amount of 20 to 500 million rubles. at a reduced rate of 1 to 3%. The federal level also offers to subsidize part of the costs of developing digital platforms and software products, for which it is planned to allocate 2 billion rubles in a year. The subsidy is provided to developers of digital platforms and software products for further implementation at industrial enterprises operating in the manufacturing sectors of the economy. For small and medium-sized enterprises, a discount of up to 50% is financed for Russian SaaS solutions for production (their list is formed by the state). The program also declares the target area "Creating retraining and advanced training programs for each branch of the manufacturing industry".

The authors also analyzed the state support measures for the digital transformation of the industry in the studied regions of the Northwestern Federal District. For comparative analysis, the following tools and elements of the digital transformation support structure were selected: the existence of a program to support the digital transformation of the industry (similar to the federal level); the use of a tool for the development of the digital environment (the existence of a common portal for the development of industry was

considered); use of a financial support tool (loan financing of digitalization projects); use of the instrument of subsidizing platforms and products; the existence of organizational support (functioning of regional business development institutions); the existence of advisory support in the field of digitalization of industry; organization of training in the field of digital transformation.

The analysis showed the following results:

1. None of the North-Western regions has its own digital transformation program.
2. In the studied regions, there are no digital platforms that are analogs of GISP; the portals of the My Business system for small and medium-sized enterprises are mainly functioning, and all the tools on the portals are aimed at such enterprises. My Business is more of an information portal than a tool for interaction with the state.
3. Debt financing of industrial development projects through regional funds exists in all regions and is, in fact, the main regional support tool. In the North-West Federal District, only the Nenets Autonomous Okrug is without an industrial development fund (although it exists in the Arkhangelsk Region, which also finances the Autonomous Okrug). The agreement with the federal fund allows the regional one to co-finance industrial development projects in 4 areas (there are no digitalization projects among them). The fund implements the remaining directions of financing at the expense of its own, regional funds. As a support measure for digitalization, the analysis considered only regional loans specifically for digitalization projects in the region's industry. It can be concluded that all regions have their own regional loans for various industrial development projects. Of these, only the Leningrad Region and St. Petersburg have loans specifically for digitalization projects. The maximum amount of an available loan in the Leningrad region is ten times lower than the federal one; in St. Petersburg it is 60% of the federal maximum.
4. The regions have an extensive system of business development support institutions (from 3 to 10 organizations involved in various types of business assistance in each of the studied regions). The services of these organizations are aimed exclusively at small and medium-sized businesses, and they have relevant areas of activity: consultations on starting a business, on reporting, etc. There is no opportunity to receive support and advice on digital transformation in the regions. The exception here is the Leningrad region, where advisory assistance is provided on digitalization projects.

There are no examples of using the tool for subsidizing platforms and products, as well as organizing training in the field of digital transformation in the studied regions. Comparing the results of calculations of the expected/actual financial results of manufacturing enterprises at the current level of ICT development in the Northwestern regions, and the analysis of support measures implemented by the federal and regional levels of government, we can conclude that there is no connection between the presence of a developed system of regional support measures and the positive result of the digital transformation of the industry in the region. The regions of the leading group, Arkhangelsk and Vologda Oblasts, do not have an industry digitalization program, do not purposefully finance digital transformation projects, and nor do they implement organizational support tools. The Leningrad region, which has a relatively developed system of regional support, does not show results that differ from, for example, the Republic of Karelia, where there is no similar system of measures. The authors conclude that the final level of digitalization of the region's industry and the degree of success in digital transformation are more dependent on federal support measures. The potential of the regional level in this process, on the one hand, remains unused, on the other hand, simply the introduction of a duplicate level with the same tools shows low results (see the example of the Leningrad Region).

Researchers indicate it is advisable to implement such measures as stimulating the full deployment of local digitalization, ensuring flexible monitoring of the problems and successes of digitalization and active dialogue with production, development of cooperation between companies and digital companies and research centers, creation of a unified state long-term strategy for the modernization of industry, training the digital skills of personnel, and promoting the development of digital companies to accelerate the digital transformation of the industry. In the draft strategy for the digital transformation of the manufacturing industries, the Ministry of Industry and Trade also indicates that "in matters of digital transformation of the Russian industry, it is especially important not to be limited to direct financial support measures. On their own, isolated from a supportive institutional environment, they will not have an impact, and they will not be able to provide wide coverage and stimulate massive growth in both demand for digital technologies and related investments". The current situation, where the emphasis is on financial measures, must be changed.

In this regard, the authors propose an updated model of state support for the digital transformation of industry (in particular, the manufacturing industry), taking into account the specifics of a federal state and the requirements for effective support. The model is shown in Figure 2.

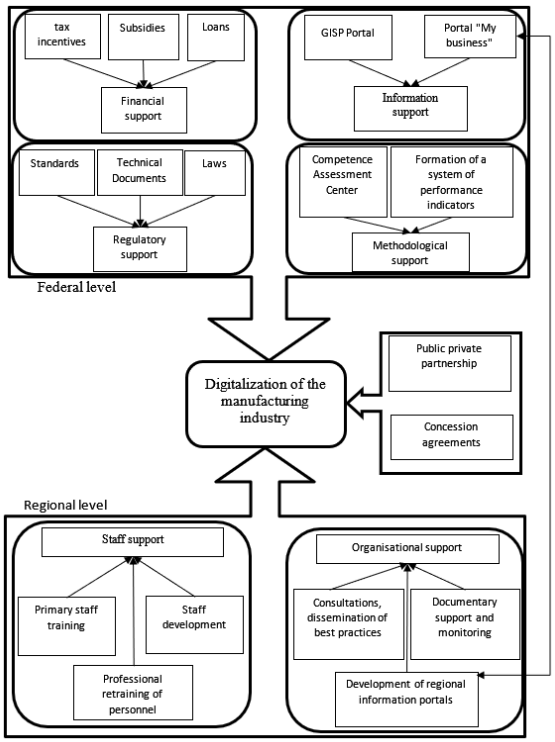

Figure 2 An updated model of state support for the digital transformation of the manufacturing industry

It is proposed to abandon the duplication of support measures at the federal and regional levels and divide the implemented tools between levels while maintaining a common strategic approach. In particular, the promising support measures proposed by the scientific community, as well as the financial incentives already being implemented, are proposed to be distributed between the levels as follows: 1. Personnel training: federal level + regional level. 2. Infrastructure of digital interaction between the state and companies: federal level through the GISP portal. 3. Stimulation of local digitalization (primarily through the dissemination of IT solutions and experience): regional level. 4. Flexible

monitoring of problems and successes of digitalization: regional level. 5. Active dialogue with industry: regional level. 6. Financial support for digital transformation: federal level. 7. Development of the regulatory environment: federal level

The regions currently have an extensive network of business support institutions in various areas. It is proposed, on the basis of the existing infrastructure, to develop organizational, advisory and other non-financial support tools, which will make it possible to take into account regional and sectoral specifics to a greater extent than when implementing non-financial measures at the federal level. The centralization of information interaction, issues of the regulatory environment and financing at the federal level allows you to unload regional finances and ensure that there is no duplication of tasks while maintaining a common strategic vision.

4. Conclusions

The study showed that the digital transformation of the industry has a significant impact through direct financial support from the federal authorities. But these measures do not consider regional and industry specifics of economic development. This approach leads to the duplication of some support areas and the absence of relevant others to a particular region, industry, or enterprise. The model proposed by the authors will establish the necessary strategic guidelines for the digital transformation of federal support of industrial enterprises and allow to consider the regional specifics through coordination with regional authorities. Further research areas may include an interaction of both federal and regional authorities in the digital transformation of industry, interregional cooperation (which is especially relevant for St. Petersburg and the Leningrad Region), state support for the digital transformation of industry in the context of achieving sustainable development goals.

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