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MONITORING DIGITAL SPACE FEATURES OF REGIONAL SOCIO-ECONOMIC SYSTEMS

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Abstract

The article presents approaches to the interpretation of "digitalization" and "digital economy" concepts in a theoretical form. A fairly broad debate regarding this category, methods of evaluation, determines its complexity and capacity, indicates the presence of scientific interest in this subject at the present stage of development of scientific thought. The relevance of the article is determined by the objective features of regional systems at the time of economic digitalization. The purpose of the study is the need for testing economic development on the basis of the Gross Regional Product with the definition of a digital space stability indicator. Methods of system correlation-regression analysis were used for this. The result is a criterial analysis of regions of the Central Federal District, which allows us to identify the stability of the digital environment of territories and identify the factors affecting the Gross Regional Product. A conclusion is drawn regarding the impact of CRM, ERP, SCM systems on the development of administrative-territorial entities.

Keywords: System, region, digitalization, monitoring

1. Introduction

The development of a digital environment at the level of mesosystems is associated with an understanding by state authorities and business of its importance for adopting and implementing competent management decisions at a regional level. Only with this approach is it possible to formulate a decision-making model based on a quantitative evaluation of socio-economic development, which is able to generate and effectively perceive both national and regional interests, determining the prospects for informatization of subjects.

The development of regional systems in the context of modernizing various fields of activity is a kind of effective lever of state regulation, which, of course, should be based on a qualitative criterion assessment. The purpose of scientific research is to monitor the features of economic development with the definition of an indicator of digital space stability. To achieve this goal it is necessary to address a number of objectives, such as:

- consider the theoretical and methodological interpretations of the "digitalization" concept;
- form and justify an indicator characterizing digital space stability of regions;
- identify the factors affecting the Gross Regional Product and build the right econometric model.

The scientific novelty of the research goal is to form a set of criteria, differing in the ability to assess the digital space of the territory based on the stability indicator and the ability to build a predictive econometric model according to the data of the Central Federal District.

2. Methods and results

The spectrum of statistical indicators that have a direct impact on the economic sphere of the regions is justified, with the subsequent selection of key ones and the stability of the digital space is identified.

3. Results

The study relevance lies in the selection and justification of criteria, which evaluate the stability of the information component with the identification of the economic development features of the Central Federal District subjects on the basis of mathematical models.

4. Discussion

Transformations in the Russian economy at their current stage are directly related to digitalization, which determines the priorities of the strategic development of territories and represents a qualitatively new basis for the transition to the next technological mode. The formation of digital economy globally was caused by the widespread dissemination of information and communication technologies, the Internet, which were introduced into various sectors of national economy and business. Considering the history of the term "digital economy", it is necessary to turn to N. Negroponte, who introduced this concept in 1995 (Negroponte, 2020). However, it was not until the researcher Tapscott (2020), who first put forward and proved a hypothesis about forming a certain digital space, a kind of "information highway" that helps increase the efficiency of not only business structures, but also public administration. A prerequisite for

this is communication between business, government and civil society institutions. Foreign scholar Schwab (2017) defined digitalization as a necessary condition and manifestation of the industrial revolution features, accompanied by the introduction of innovative technologies in production, contributing to a significant increase in labor productivity, which ultimately affects not only the business sector, but also the socio-economic system as a whole. The development of territories in the digitalization era can be considered under various analytical planes, however, Zelentsova and Tikhonov (2020), Dudin et al. (2020), Lee and Falahat (2019) and Berman (2012) consider the key elements and factors determining them to be knowledge.

In Russia, researchers' interest in forming a digital economic space has grown significantly lately (Piskun et al., 2019). According to scientists Kheyfets and Chernova (2019), Gray and Rumpe (2017), Viollaz (2019), Stolterman and Croon (2004), Matt et al. (2015), this is especially shown in revealing the relationship between the results of the application of information technologies by the business sector and the resulting performance indicators of the constituent entities of the Russian Federation - regions and municipalities (Matt et al., 2015). A new type of economy should be based on electronic resources that allow to process and revise large amounts of data (Popov & Semyachkov, 2018). States and entities that use digital technologies more intensively, including in the process of strategic management and administrative decision-making, have more competitive advantages compared to those who use them to a lesser extent.

Considering the position of Russia, according to the ICT indices, the development of e-government and a global cybersecurity index in the world, we can focus on the fairly big gap between our country and the leaders in this field. Only one of the indices is an exception (Figure 1).
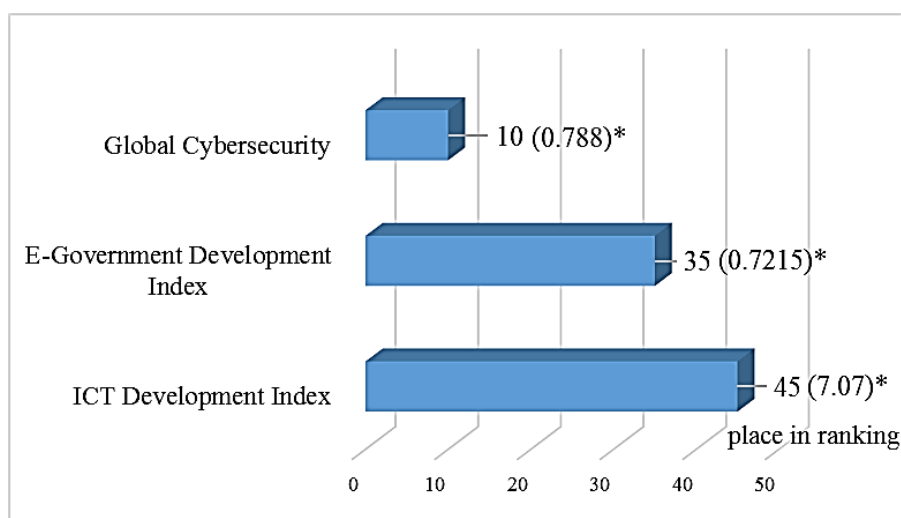

Figure 1. Russia's place in the ranking of countries by digitalization indices (Note* - the value of the corresponding index is indicated in parentheses)

In world practice, the indicators of the digital environment development can be determined by the share of the country's economy in the global economic space (which amounted to 2% in 2016, while the United States - 25%, Japan - 16%, China - 8%, Germany - 6%) (Big information explosion…, 2017) and the share of the digital economy in GDP (figure. 2). Currently, the genesis of this type of technology has been identified as one of the priority vectors for the development of various areas of management, because

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full-fledged evolutionary digitalization should become the basis for high-quality scientific, technical, administrative transformations and implementation of long-term goals.

The term digital economy, according to the authors, is considered as a system of relations aimed at improving the efficiency of the territories' economy, covering various areas of public life and economic activity, based on digital data transformation.
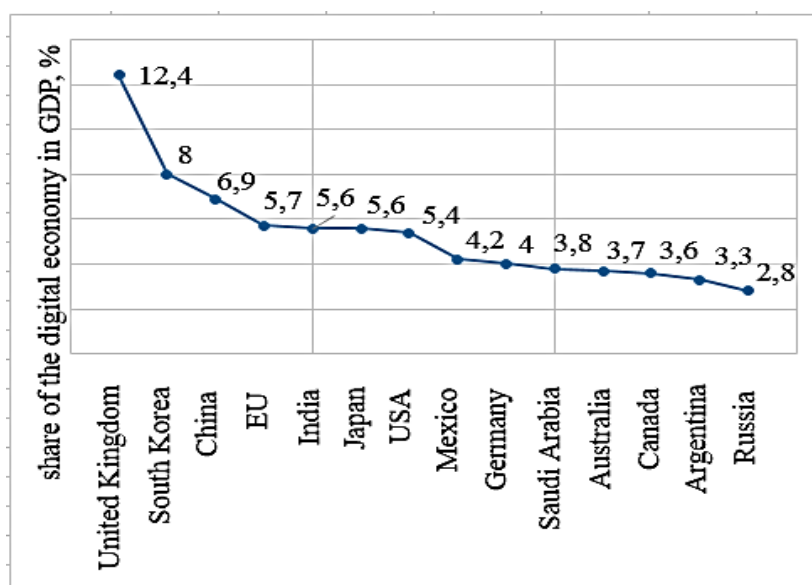

Figure 2. Share of the digital economy in GDP for the selected G20 countries for 2016 (Note* - Compiled on materials of The Boston Consulting Group)

It is interesting to study the forming of methods and methodologies for diagnosis, the study of the socio-economic development of regions which take into account the digital component. To this end, a number of researchers have resorted to methods of expert evaluation and cluster analysis, which allows to group subjects depending on the degree of digital technologies (Bahci, 2005) use, econometric modelling (Skantsev et al., 2019) and discriminant analysis (Nizhegorodtsev et al., 2017). However, the lack of a unified, universal method (methodology) that takes into account the spatial and dynamic features of the territories, and the ambiguity of scientists' opinions regarding their results, fuel the interest of scientific researchers in this issue.

It is possible to diagnose the state of regional socio-economic systems in the current digitalization environment using a set of indicators, methods that vary quite a lot, however, among them quite often the choice falls on Gross Regional Product (GRP), as the resulting one and characterizing the overall economic development and emerging trends (Vertakova & Polozhentseva, 2018). According to the authors, this criterion can be considered as main for characterizing systems; indicators were also proposed that characterize the level of development of digitalization directly and affect GRP with the construction of regression models that allow future data forecasting with calculation of the stability index of digital space. It characterizes the ability of the system to function, to be in balance. The study was conducted on the subjects of the Central Federal District (CFD) for 2017.

A number of indicators could be added to the considered ones, however, the choice was made of those that could potentially affect the change in the GRP growth rates and some of which, in the future, can be selected to calculate the stability of digital space, excluding interdependent factors, that would confirm the reliability of the selected criteria. Initial indicators for analysis (table 1) (Regions of Russia. Socio-economic indicators, 2020).

X1 - server utilization, %;

X2 - the percentage of organizations using broadband Internet access;

X3 - the use of special software (in %) of the total number of organizations surveyed for scientific research;

X4 - the use of information technology to solve organizational, administrative and economic problems, %;

X5 - information technologies for managing automated production and / or individual technical means and technological processes, %;

X6 - CRM, ERP, SCM systems used by organizations, %;

X7 – internal costs of research and development, million rubles

Table 1. Digital environment indicators affecting GRP

Subject	Indicator and its value (for 2016)							
	GRP (Y)	*X1*	*X2*	*X3*	*X4*	*X5*	*X6*	*X7*
Belgorod region	506 420.9	53.7	87.5	2.6	53	14.3	19.5	1921.1
Bryansk region	253 100.4	46.8	87.4	0.9	57.9	10.6	14.2	977.7
Vladimir region	300 273.6	52.4	87.8	2.3	50	13.8	20	5391.3
Voronezh region	370 610.4	55.3	88.4	3.2	56.3	13.8	18.9	8164.5
Ivanovo region	182 398.1	51.8	86.7	2.1	53.4	12.3	16.9	585.7
Kaluga region	411 565.3	53.9	87.5	3.3	50.4	14.6	20.7	6070.9
Kostroma region	256 848.4	42.9	78	2.4	51.3	13.5	15	130.8
Kursk region	346 340.2	39.6	78.8	1.6	53.3	12.1	16.8	5936.1
Lipetsk region	431 821.2	47.8	91.9	2.1	50.9	12.7	15.6	291.1
Moscow region	509 545.2	59.5	86.4	3.5	51.2	16.5	28.4	119715.9
Orlov region	285 354.0	43.5	85.1	1.9	53	11.4	13.9	976.4
Ryazan region	320 764.0	44.9	85.6	2.6	55.6	13.6	18	1594.4
Smolensk region	296 289.6	51	86.5	1.9	50.6	12.5	11.3	1604.5
Tambov region	289 847.1	42.4	94.6	2.4	61.4	12.3	15.8	1079.2
Tver region	297 625.2	40.7	78.4	1.7	46.2	10.5	11.9	4644.3
Tula region	371 709.4	53	82.4	3	54.4	13.9	19.9	5974.9
Yaroslavl region	402 639.5	60.8	89.1	2.9	56.9	16.6	21.9	6938.5
Moscow	1263698	74.8	94.9	6.6	65	19	29.5	358214.8

Based on the available official statistics, a number of factors were selected which impact the development of digital environment in the subject of the federation. To eliminate multicollinearity of the indicators, a pair correlation analysis was performed, which allows us to filter out the interdependent ones and to further build an econometric model that characterizes the stability of digital space of mesoterritories. The proposed model has the form (1):

$$DSSI_{x_i} = \sqrt{\sum_{i=1}^{n}(1-\frac{X_i}{X_{max}})} \qquad (1)$$

Where $DSSI_{x_i}$ is the subject's digital stability index;

X_i - the importance of the digitalization factor in the i region;

X_{max} - the maximum value of the digitalization factor by i region.

The index $DSSI_{x_i}$ characterizes the ability of the mesoeconomic system to function, maintain its structure and be in equilibrium. The value of this indicator will tend to zero, that is, the closer it is to it, the more stable the digital environment and the functioning of technologies in the region.

The calculation results showed that for further computations X_2, X_3, X_5, X_6, X_7, X_8, can be used, and between which there is no relationship. The next step in the study was the calculation of this indicator with the determination of the subject's (rank's) location in the context of the Central Federal District. According to condition ($DSSI_{x_i}$), a higher rank is assigned to the system and equated to unity (table 2). Further allocation of subjects occurs according to the principle: the lower the value, the higher in the rank list.

Table 2. Digital Space Stability Index Value

№	Subject (region)	Indicator $DSSI_{x_i}$ value
1	Moscow	1.180648
2	Moscow region	1.40936
3	Yaroslavl region	1.445999
4	Kaluga region	1.481168
5	Voronezh region	1.501445
6	Tula region	1.505
7	Belgorod region	1.518881
8	Vladimir region	1.540665
9	Ryazan region	1.566381
10	Tambov region	1.585996
11	Lipetsk region	1.595726
12	Ivanovo region	1.610925
13	Kostroma region	1.644483
14	Kursk region	1.65574
15	Orlov region	1.659883
16	Smolensk region	1.70314
17	Bryansk region	1.716772
18	Tver region	0

Based on the data in the table (see table 2), we draw a conclusion that the development of information and communication systems and products predominates in the city of Moscow, Moscow, Yaroslavl, Kaluga, and Voronezh regions, which make up the top five unique leaders, however, one cannot but notice a significant gap between all subjects and Moscow, which characterizes it as the main territory for development, implementation and use of digital products, which have an impact on the development of the economy as a whole.

In the course of further research, the task was to build an econometric model that describes the influence of digitalization factors on the Gross Regional Product (*Y*). At the preliminary stage of calculations (based on pair correlation analysis), only two of them were selected that met the requirements: the level of correlation coefficient was above 0.7 and the significance of Student's statistics did not exceed the permissible limits ($p \leq 0.05$), which would justify the need to include them into the linear regression

equation. The results of the analysis confirmed the significance of the trait X_6 (p=0.00053), with a correlation level of 0.73. However, the remaining indicators remained statistically insignificant, although by factor X_2 the criterion level p turned out to be acceptable, but there was a low correlation with GRP (R=0.47) therefore it is necessary to include only the indicator X_6 in the econometric model and assess the degree of influence on the "Gross Regional Product" (Y_x). Also, according to the calculation data, the level of the Fisher calculation criterion significantly exceeds the tabulated indicator (F=18.63), therefore, the explained variance is significantly greater than the unexplained, and the linear regression model is correct. The results of the calculations are presented in the table (table 3).

Table 3. Results of correlation and regression analysis of factors Y and X_6

Index	Coefficient	Standard error	t(16)	p-value
Free term	-242876	152574.1	-1.59186	0.130978
X_6	34944	8096.3	4.31606	0.000533

The resulting dependence of Y on X_6 can be represented as the following equation (2):

$$Y = 34944X_6 - 242876 \tag{2}$$

A conclusion can be made, according to this equation, that change of one unit of CRM, ERP, SCM systems used by organizations will lead to a change in the Gross Regional Product by 34.944 times, taking into account the value of the free term by -242876. It is fair to say that the use of software products, applications used for planning, accounting, automation and control of business processes in the organization directly affects the improvement of its performance, profit growth and profitability, which is reflected in the increase in output in monetary terms designed to meet the needs of individuals and legal entities. Therefore, based on the interpretation of GRP, there is a logic of dependence on the factor X_6.

The lack of consensus, as well as significant differences in the assessment methods, their systematic characterization of the importance of digitalization factors at aregional level, as well as the degree of their influence on the economic development of territories, determines the relevance of the chosen research topic. During monitoring, the authors studied theoretical and methodological interpretations of the concepts of "digitalization", "digital economy" and proved the influence of the information component, namely, those CRM, ERP, SCM - systems used by organizations on GRP with the construction of the correct econometric model, which allows future forecasting by selected criteria. The index of "digital space stability" was developed, which was defined as the ability of the mesoeconomic system to function, maintain its structure and be in equilibrium, and it was calculated for the subjects of the Central Federal District. It was substantiated that the closer the value of this indicator to zero, the more stable the digital technologies in the region are functioning and developing. According to this conclusion, a new approach was formed, on the basis of which a graduation of subjects was made, which allows to determine their position in terms of information and communication technologies development. Thus, the developed system of criteria can be used, including when making strategic decisions and assessing the economic situation in the regions by executive authorities on various levels in the context of large-scale digitalization of management structures.

5. Conclusions

A set of evaluation tools has been developed taking into account the peculiarities of the regional genesis of a single federal district, which can be used in analytical and practical activities of regional executive authorities.

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