

Digital analysis as a tool for assessing regional opportunities for the transition to digital technologies

I B Manzhosova^{1*}

¹ Stavropol State Agrarian University, 10 Zootechnicheskiiy str., Stavropol 355017
Russia

E-mail: i.manzhosova@yandex.ru

Abstract. The study presents a digital analysis technique consisting of seven successively implemented blocks, the analytical potential of which allows one to systematically assess the impact of digitalization processes on the regional economy, the readiness to introduce new digital technologies, the degree of innovation activity of economic entities. More than that, this technique allows to determine the presence of deficiencies in the resources that prevent to digital technology. The method of digital analysis can be used to correct the current policy in the field of production modernization, to make management decisions in terms of prospects, and the readiness of transition of individual economic entities to the systemic application of digital technologies, to form data for developing regional modernization programs. The advantage of this methodology is the use of a variety of assessment indicators: quantitative and qualitative, financial and non-financial, sectoral and general economic, absolute and relative, characterizing both the internal and external environment, which allows to reveal obvious and hidden relationships between the processes of digital modernization at the macro and micro levels, unleash the existing potential, and determine the direction of further modernization, identify the current technological state of the economy. The methodological support is built on the basis of individual elements of the "Pattern" method, which makes it possible to identify asymmetry in the digital development of regions and subsequently provide information on the presence of regional competitive advantages for the introduction of digital technologies.

Keywords: digital analysis, indicator, digital technology, transition, economy

1. Introduction

The digital analysis methodology is applicable to the economy as a whole, and not to individual sectors, since at this stage, it is important to establish the overall level of digitalization of the economy and the development of a digital culture, which is expressed in the systematic adoption of management decisions based on the collection of a large data array using computer technology. My unique study significantly contributes to the existing body of high-quality research on the issues of digital technologies, digital economy, informatization [1], [2], [3], [4], [5], [6], [7].

2. Materials and Methods

To assess the digitalization level of a particular region, the most relevant indicators, divided into seven analytical blocks, are selected, in the context of which a digital analysis is carried out: "D" is Deficits, "Ia" is Innovation in agriculture, "G" is Land, bio-resources, climate, "I" is Infrastructure, "T" is

Technique, Technology, “A” stands for Administrative processes, “L” is the System of legislation and regulation of processes.

3. Results

The first analytical block “D-deficits” contains indicators reflecting obvious shortcomings in the region’s digital transformation system, such as: high tariffs for the Internet and other means of communication, a share of organizations using the Internet with a low data transfer rate, an insufficient access to information and communication services spheres.

The high value of these indicators is characterized by the presence of deficits in the development of the digital economy at the regional level. The remaining indicators are assessed as regional advantages. Thus, when calculating an integral value of the digital analysis, the indicators of the D-deficits block should be subtracted from the total points.

In the first group of indicators, the Stavropol Territory, which dominates in other indicators, has quite significant deficits in the development of the digital economy. So, in the Stavropol Territory, the highest tariff for providing a subscriber with a permanent use of a subscriber line is noted regardless of its type (174.00 rubles per month with an average Russian rate of 190.48 rubles per month), as well as the tariff for one minute of local telephone connection with a time-based payment system (0.56 rubles per minute, with an average figure in the North Caucasus Federal District of 0.50 rubles and an average Russian rate of 0.57 rubles). It should be noted that the affordability of information and communication technology services in the North Caucasus Federal District is higher than on average nationally (Table 1).

With regard to innovation, here the North-Caucasian Federal District is significantly inferior to the average Russian indicators, while the Stavropol Territory occupies a leading position in such indicators as: the share of research and development costs aimed at developing the economy in the total domestic expenditure on research and development, the share of organizations that received orders for manufactured goods (works, services) over the Internet, a total number of surveyed organizations and the percentage of organizations that placed orders for goods (work, services) on the Internet, in the total number of organizations surveyed. According to 3 indicators, the studied region is in third place.

In the “G - Land, Climate and Biological Resources” block of indicators, the dominance of the Stavropol Territory is even more obvious. The relatively low value of the indicator is observed only in relation to the share of organizations that have implemented innovations that ensure increased environmental safety in the production of goods, works, services and reduced emissions of carbon dioxide (CO₂), including using digital technologies. According to this indicator, the region is in 4th place (Table 2).

More than that, according to the level of digital infrastructure development, the Stavropol Territory also has undoubted advantages, leading in 11 indicators out of 16. The most obvious areas for improvement in this case are the low proportion of students in educational programs of primary, basic and secondary general education in the total population, and the lowest in the North Caucasus Federal District number of collective use points (access) with Internet access per 10 thousand people of the population. It should be noted that absolutely all indicators characterizing the development of digital infrastructure in the North Caucasus Federal District are inferior to the average Russian level (Table 3).

According to the nine indicators of the development of digital technologies, the Stavropol Territory holds a leading position, while the region is in second place for the remaining 5 indicators (Table 4). This block of indicators also shows a significant lag of the regions of the North-Caucasian Federal District from the average Russian levels.

Only the Stavropol Territory shows an excess of average Russian indicators (by 9 indicators), the remaining regions are significantly behind, which to some extent confirms the leading role of the Stavropol Territory in the development of digital technologies for the thief throughout the macro region.

In the block of administrative indicators, the Stavropol Territory leads only in two indicators, which indicates a strong need to increase the effectiveness of sectoral and regional management in providing financial and methodological assistance to the real sector of the economy for the transition to digital technologies.

In other regions, the opposite situation is observed when the region is doing quite a lot for digital transformation, but an insufficient level of economic development does not allow a full transition to digital technologies.

In the block of indicators “L - System of Legislation and Regulation of Processes,” it is noteworthy that the North Caucasus Federal District exceeds the average Russian indicators for the share of electronic document management between government bodies in the total volume of interdepartmental document management, in other indicators the North Caucasus Federal District is lower than the national average.

In the Stavropol Territory, an excess of average Russian values is noted for such indicators as: “organizations that used special software to solve organizational, managerial and economic problems” (as a percentage of the total number of examined organizations of the subject of the Russian Federation), “a share of electronic document management between government bodies, in the total volume of interdepartmental document management, %,” and “a share of organizations using electronic document management systems, in the total number of organizations examined, %” (Table 5).

Table 5. Indicators for assessment “L – System of legislation and regulation of processes”.

Regions	L – System of legislation and regulation of processes							
	X ₆₁	X ₆₂	X ₆₃	X ₆₄	X ₆₅	X ₆₆	X ₆₇	X ₆₈
Russian Federation	11.2	52.4	6584.5	50.1	66.1	-	1	1
North Caucasian Federal District	6.7	37.5	38.4	65	58.2	-	1	1
The Republic of Dagestan	4.2	25	2.6	44.3	42.3	11	1	1
The Republic of Ingushetia	4.4	36	1.8	30.9	97.1	19	0	0
Kabardino-Balkarian Republic	6.2	21	1.4	51	58.8	24	0	0
Karachay-Cherkess Republic	7.1	50.8	4	52.8	69.4	18	0	0
Republic of North Ossetia-Alania	6.6	41.7	18.5	52.1	56.4	37	1	1
Chechen Republic	3.7	19	4.6	87.4	40.9	15	0	1
Stavropol region	10.6	56.3	5.5	63.1	75.5	18	1	1
X_{imax}	10.6	56.3	18.5	87.4	97.1	37	1	1

X₆₁ captures those organizations that used special software for design (as a percentage of the total number of examined organizations of the subject of the Russian Federation); X₆₂ focuses on those organizations that used special software to solve organizational, managerial and economic problems (as a percentage of the total number of organizations examined in a subject of the Russian Federation); X₆₃ reflects the costs for employee training related to the development and use of ICT, million rubles; X₆₄ is a share of electronic document management between government bodies, in the total volume of interdepartmental document management, %; X₆₅ – a share of organizations using electronic document management systems in the total number of organizations examined, %; X₆₆ – an activity of sectoral authorities in information and methodological support of projects related to the implementation of digital technologies in agriculture. It is determined by the number of developed guidelines in open sources; X₆₇ – the presence of strategic documents (strategy, concept, program, roadmap, etc.) at various levels of sectoral and regional governance on digitalization of agriculture; X₆₈ – an interaction of authorities in implementing the digitalization policy of agriculture. This indicator is assessed by the presence of an existing agreement between relevant organizations, Ministries, and leading scientific and educational institutions of the region.

We note that all the indicators studied are heterogeneous, and in order to rank the regions by the level of development of digital technologies, they need to be standardized (lead to the most optimal comparison base). As a comparison base for standardized values, not only the average regional indicators were taken, but the best values:

$$T_{ij} = X_{ij} / X_{imax}$$

where X_{ij} stands for the actual values of regional digitalization indicators; X_{imax} – the highest values among all regions; I = 1, 2, ..., n – the number of indicators; J = 1, 2, ..., n – the number of regions.

Table 1. Indicators for assessing the block “D-deficits” and block “Ia-innovation.”

Regions	D-deficits							Ia-innovation				
	X ₁	X ₂	X ₃	X ₄	X ₅	X ₆	X ₇	X ₈	X ₉	X ₁₀	X ₁₁	X ₁₂
Russian Federation	41.2	190.48	571.48	1.39	0.57	58.4	1.36	50.1	39.8	143.2	20.1	41.2
North Caucasian Federal District	32.4	158.06	560.3	1.25	0.5	50.1	0.25	11.7	38.4	47.6	13.4	32.4
Republic of Dagestan	18.1	...	661.6	1.88	...	51	0.15	10.7	32	46	5.7	18.1
Republic of Ingushetia	33.8	140	1000	2.86	0.24	54.2	0.11	9.3	9.6	-	15.3	33.8
Kabardino-Balkarian Republic	27.9	163	491.23	1.13	0.48	56.1	0.47	17.9	10.3	71.6	11.9	27.9
Karachay-Cherkess Republic	38.4	163	498.33	1.54	0.48	52.9	0.68	17	3.1	17.2	15.6	38.4
Republic of North Ossetia-Alania	32.7	163	572.08	1.58	0.48	49.1	0.27	11.4	29.7	126.8	11.6	32.7
Chechen Republic	22.4	...	1930.56	1.08	0.22	29.6	0.15	6.9	32.8	11.8	5	22.4
Stavropol region	50.2	174	408.52	0.95	0.56	57.6	0.28	12.6	64.5	53.9	24.7	50.2
X _{imax}	18.1	140	408.52	0.95	0.22	29.6	0.68	17.9	64.5	126.8	24.7	50.2

X₁ is the proportion of the population having the opportunity to receive one television program of terrestrial digital terrestrial broadcasting (data of the Ministry of Communications of Russia at the end of the year; as a percentage of the total population); X₂ is a tariff for providing a subscriber with a subscriber line for permanent use, regardless of its type, month (at the end of the period, rubles); X₃ is subscription fee for Internet access, rub. month; X₄ stands for providing a local connection (conversation) via cellular, minutes (at the end of the period, rubles); X₅ is a tariff for one minute of local telephone connection with a time-based payment system, minute (at the end of the period, rubles); X₆ is a proportion of organizations using access to the Internet at a speed of less than 2 Mbps, in the total number of organizations, %

X₇ is a resource base of research and development and innovation. The share of domestic research and development costs, in % of gross regional product (GRP); X₈ is an institutional environment. A number of researchers performing research and development per 10,000 employed in the economy, people; X₉ is a share of research and development costs aimed at developing the economy in the total volume of domestic research and development costs, %; X₁₀ is an efficiency of R&D and innovation. A number of patents for inventions issued by Rospatent to the Russian applicants per 1 million people, pieces; X₁₁ is a share of organizations receiving orders for manufactured goods (works, services) via the Internet, in the total number of organizations surveyed, %; X₁₂ is a share of organizations that placed orders for goods (work, services) on the Internet, in the total number of organizations examined, %.

Table 2. Indicators for the assessment of the block “G – Land, climate and biological resources.”

Regions	G - Land, Climate and Biological Resources										
	X ₁₃	X ₁₄	X ₁₅	X ₁₆	X ₁₇	X ₁₈	X ₁₉	X ₂₀	X ₂₁	X ₂₂	X ₂₃
Russian Federation	-	-	-	-	-	14670.8	41.8	51	37.3	34.5	443436.8
North Caucasian Federal District	257		15.3	2.1	26.7	653.8	40	50	50	50	24070
Republic of Dagestan	64	2	8.7	2.2	20	92.6	-	50	50	50	1199.8
Republic of Ingushetia	17	0	12.4	2.1	12	19.4	-	-	-	-	220.2
Kabardino-Balkarian Republic	19	0	17.6	1.8	31	64.2	50	50	50	50	2575
Karachay-Cherkess Republic	22	1	14.2	1.15	26	3.6	-	-	-	-	549.8
Republic of North Ossetia-Alania	28	0	19.1	1.7	29	36.3	66.7	-	-	-	7.5
Chechen Republic	20	1	12.3	1.2	24	59.5	100	100	100	100	4974.4
Stavropol region	87	3	22.9	4.3	45	378.1	66.7	66.7	33.3	66.7	14543.4
X _{imax}	87	3	22.9	4.3	45	378.1	100	100	100	100	14543

X₁₃ is a number of patents for an invention registered in the Russian Federation per year on the subject of agriculture and the use of biological resources, units; X₁₄ stands for a number of patents for inventions that have a legal protection abroad on the subject of agriculture and the use of biological resources, units; X₁₅ is a share of publications carried out jointly with business companies in the field of biotechnology, %; X₁₆ reflects a share of publications carried out jointly with foreign scientists in the field of biotechnology, %; X₁₇ is a number of new educational programs in the field of biotechnology, pcs.; X₁₈ stands for domestic expenditures on research and development in the field of agricultural sciences, million rubles; X₁₉ proxies those organizations which have implemented innovations that ensure increased environmental safety in the process of production of goods, work, services and reduce material costs for producing a unit of goods, work, services; X₂₀ reflects those organizations which have implemented innovations that ensure increased environmental safety in the production of goods, works, services and reduce energy costs for producing a unit of goods, works, services; X₂₁ reflects those organizations that have implemented innovations enhancing environmental safety in the production of goods, work, services, as well as reducing atmospheric emissions of carbon dioxide (CO₂); X₂₂ captures a number of organizations that have implemented innovations that ensure increased environmental safety in the production of goods, work, services by replacing raw materials with safe or less dangerous ones; X₂₃ stands for investments in fixed assets of agricultural organizations, million rubles.

Table 3. Indicators for the assessment of the block “I-infrastructure.”

Regions	I-infrastructure															
	X ₂₄	X ₂₅	X ₂₆	X ₂₇	X ₂₈	X ₂₉	X ₃₀	X ₃₁	X ₃₂	X ₃₃	X ₃₄	X ₃₅	X ₃₆	X ₃₇	X ₃₈	X ₃₉
Russian Federation	10.7	22.2	50	61.1	26.2	83.2	16.6	17.3	33	26.2	200.3	1.7	21	79.9	1079.3	88.1
North Caucasian Federal District	12.9	8.3	43	48.2	14.6	80.3	11.2	10.5	28	14.6	137.2	1.7	8.4	65.7	303.8	73
Republic of Dagestan	12.8	1.3	34	26.4	7.9	63.5	5.4	4.8	21	7.9	117.7	2.1	2.4	54.6	115.6	65.3
Republic of Ingushetia	14.1	1.4	37	50.2	19.3	92.7	16.4	8	26	19.3	135.8	0.4	1	57.1	379.7	22.7
Kabardino-Balkarian Republic	11.5	11.7	37	38.6	15.1	81.1	14.5	11.1	24	15.1	138	1.3	9.5	71.1	372.5	100
Karachay-Cherkess Republic	10.9	9.1	44	52.4	16.5	85.5	12.9	12.5	30	16.5	131.8	1.8	10.1	60.7	435.8	98.5
Republic of North Ossetia-Alania	12	18.9	40	48.4	15.1	75	10.8	11.8	25	15.1	149.9	1.2	12.7	72.4	511.3	93.7
Chechen Republic	19	1.1	44	46.6	6.9	85.5	7	4.4	27	6.9	130.3	2.8	4	65.8	118	23.9
Stavropol region	10.2	16.9	49	70.1	23.7	91.2	16.9	18.2	32	23.7	159.6	1.1	16.7	76.7	496.7	98.2
X_{imax}	19	18.9	49	70.1	23.7	92.7	16.9	18.2	32	23.7	159.6	2.8	16.7	76.7	511.3	100

X₂₄ is a proportion of students in educational programs of primary, basic, and secondary general education in the total population,%; X₂₅ is a telephone density of fixed communications (including payphones) per 100 population (calculation according to the Ministry of Communications of Russia, at the end of the year), units; X₂₆ is a number of personal computers per 100 employees of organizations, pieces; X₂₇ is a share of organizations using local area networks in the total number of organizations surveyed,%; X₂₈ is a share of organizations using the Internet in the total number of organizations surveyed, %; X₂₉ is a proportion of organizations using broadband Internet access, in the total number of organizations, %; X₃₀ is a share of organizations using the Extranet in the total number of organizations surveyed, %; X₃₁ is a proportion of organizations that use third-party open source operating systems (such as Linux) in the total number of organizations surveyed; X₃₂ is a number of personal computers with an access to the Internet, per 100 employees of organizations, pieces; X₃₃ is a proportion of organizations using the Internet in the total number of organizations surveyed, %; X₃₄ is a penetration of mobile radiotelephone (cellular) communication per 100 people, units; X₃₅ is a number of points of collective use (access) with an access to the Internet, per 10,000 people, units; X₃₆ is a number of fixed broadband Internet subscribers per 100 population, units; X₃₇ is a number of the mobile broadband Internet subscribers per 100 population; X₃₈ is a volume of postal services per 1 resident (according to the Ministry of Communications of Russia), rub.; X₃₉ is a proportion of telephon settlements in rural areas, in the total number of rural settlements (calculations according to the Ministry of Communications of Russia, at the end of the year, %)

Table 4. Indicators for the assessment of the block “T – Technique, technology” and “A – Administrative processes”.

Regions	T - Technique, technology										A - Administrative processes										
	X ₄₀	X ₄₁	X ₄₂	X ₄₃	X ₄₄	X ₄₅	X ₄₆	X ₄₇	X ₄₈	X ₄₉	X ₅₀	X ₅₁	X ₅₂	X ₅₃	X ₅₄	X ₅₅	X ₅₆	X ₅₇	X ₅₈	X ₅₉	X ₆₀
Russian Federation	2.4	7.5	389698.3	-	87.2	44.3	77.2	10.3	34.4	12.2	22	36.2	47.4	88.3	1.7	94.8	88.2	60.1	63.1	4.7	14.7
North Caucasian Federal District	1.5	2.9	9826.5	-	76.9	36.5	69.7	6	28.2	5.8	12.9	27.1	46.8	80.2	0.9	95.5	89.8	56.4	55.2	3.4	10
Republic of Dagestan	0	1.1	1327.5	63.5	61.1	22.3	53.2	2.2	19.6	2	5	14.7	31.5	66.2	0.8	90.9	83.9	68.2	42.7	1.3	5
Republic of Ingushetia	0	4.8	454.5	92.7	100	39.3	95.6	10.2	33.5	7.3	10.5	28.7	73.8	100	0.6	100	91.7	57	73.1	5.5	8.7
Kabardino-Balkarian Republic	0.9	3.8	1103.4	81.1	77.8	36.6	70.6	6.9	25.5	5.3	14.2	26.1	42	82.8	1	94.6	91.6	62.9	51.8	5.3	10
Karachay-Cherkess Republic	0.1	1.8	566.6	85.5	88.2	43.9	81.2	7.3	30.9	8.2	15.2	32.8	49.8	87.9	1.2	95.6	90.8	54.8	65.2	5.6	11.4
Republic of North Ossetia-Alania	0.2	3.2	713.5	75	78	37.4	71.1	5.6	28.8	6.6	12.6	31	45.4	78.4	0.4	91.7	84.7	53.3	52.5	3.4	10.9
Chechen Republic	0.4	0.2	1448.3	85.5	58.6	23.7	53.9	2.4	20.1	2.4	5.7	16.4	52.3	67.4	1.1	98.1	93.9	36.8	39.1	1.6	6.2
Stavropol region	2.1	4.9	4212.7	91.2	95.3	53.8	87	10.4	39.6	10.3	23.1	41.8	56.1	95.7	1	99.2	93.5	57.3	72.5	5	16.1
X _{imax}	2.1	4.9	4213	92.7	100	53.8	95.6	10.4	39.6	10.3	23.1	41.8	73.8	100	1.2	100	93.9	68.2	73.1	5.6	16.1

X₄₀ are the R&D and innovation performance. A share of technological innovation costs in the total volume of goods shipped, work performed, and services; X₄₁ is a proportion of organizations implementing technological innovations in the total number of organizations surveyed; X₄₂ is a volume of investments in fixed assets aimed at the acquisition of information, computer and telecommunication equipment (excluding small businesses and the volume of investments not observed by direct statistical methods) in actual prices, million rubles; X₄₃ is a share of organizations using broadband Internet access, in the total number of organizations; X₄₄ is a proportion of organizations using the means of protecting information transmitted over global networks, in the total number of organizations surveyed, %; X₄₅ is a share of organizations that use encryption in the total number of organizations surveyed, %; X₄₆ is a proportion of organizations that use electronic signature tools in the total number of organizations surveyed, %; X₄₇ is a share of organizations using CRM systems in the total number of organizations surveyed, %; X₄₈ is a proportion of organizations that allocated technical means for mobile Internet access to their employees, in the total number of organizations surveyed, %; X₄₉ is a share of organizations using ERP systems in the total number of organizations surveyed, %; X₅₀ is a proportion of organizations that had special software for managing sales of goods (works, services), in the total number of organizations surveyed, %; X₅₁ is a proportion of organizations that had a special software for managing the procurement of goods (works, services), in the total number of organizations examined, %; X₅₂ is a share of organizations that had a website in the total number of organizations surveyed, %; X₅₃ is a proportion of organizations using emails in the total number of organizations surveyed, %.

X₅₄ is a proportion of people employed in the ICT sector in the total number of employed people, %; X₅₅ is a proportion of UCL and OMI using the Internet, in the total number of examined organizations of UGA and OMI; X₅₆ – a proportion of UGV and OMS using the Internet in the total number of UGV and OMS organizations surveyed at a speed of 256 Kbps; X₅₇ is a share of the public organizations and the compulsory medical insurance bodies having a data transfer rate over the Internet of at least 2 Mbps, in the total number of organizations and compulsory medical insurance, %; X₅₈ is a proportion of organizations that have used electronic data exchange between their and external information systems in exchange formats (EDIFACT, EANCOM, ANSI X12; XML-based standards, for example ebXML, RosettaNet, UBL, papiNET; proprietary standards agreed between organizations), in the total number of organizations examined; X₅₉ is a proportion of organizations using SCM systems in the total number of organizations surveyed; X₆₀ reflects those organizations that used special software to manage an automated production and / or individual technical means and technological processes (as a percentage of the total number of organizations examined in a subject of the Russian Federation).

Then, the standardized values of all indicators and the arithmetic average for each of the analytical blocks in the context of 7 regions were calculated (Table 6). As a result of the study, it was found that the highest level of digital technology development was noted in the Stavropol Territory. The Republic of North Ossetia-Alania was in second place, and the Kabardino-Balkarian Republic was in the third. Further in descending order are the following regions of the North-Caucasian Federal District: Karachay-Cherkess Republic, Chechen Republic, Republic of Dagestan, Republic of Ingushetia (Table 7).

Based on the results of the digital analysis of the regions of the North-Caucasian Federal District according to the “Pattern” method, a typological grouping of territories was carried out:

- Regions with a progressive level of development of the digital economy;
- Regions with an average level of development of the digital economy;
- Regions with an inert level of the digital economy;
- Depressed regions with a critically low level of development of the digital economy.

In accordance with the developed methodology, the absence of regions with a progressive level of development of the digital economy in the North Caucasus Federal District was identified.

Only the Stavropol Territory was included in the group with an average level of development of digital technologies, the remaining regions of the North Caucasus Federal District fell into the group of regions with an inert level in the state of the digital economy (Table 8).

Table 6. Standardized values of indicators of the block “D-deficits” and block “Ia-innovation.”

Regions	D-Deficits							Ia-innovation				
	X ₁	X ₂	X ₃	X ₄	X ₅	X ₆	X ₇	X ₈	X ₉	X ₁₀	X ₁₁	X ₁₂
Republic of Dagestan	1.000	0.000	1.620	1.979	0.000	1.723	0.221	0.598	0.496	0.363	0.231	0.361
Republic of Ingushetia	1.867	1.000	2.448	3.011	1.091	1.831	0.162	0.520	0.149	0.000	0.619	0.673
Kabardino-Balkarian Republic	1.541	1.164	1.202	1.189	2.182	1.895	0.691	1.000	0.160	0.565	0.482	0.556
Karachay-Cherkess Republic	2.122	1.164	1.220	1.621	2.182	1.787	1.000	0.950	0.048	0.136	0.632	0.765
Republic of North Ossetia-Alania	1.807	1.164	1.400	1.663	2.182	1.659	0.397	0.637	0.460	1.000	0.470	0.651
Chechen Republic	1.238	0.000	4.726	1.137	1.000	1.000	0.221	0.385	0.509	0.093	0.202	0.446
Stavropol region	2.773	1.243	1.000	1.000	2.545	1.946	0.412	0.704	1.000	0.425	1.000	1.000

Table 6. (continued) Standardized values of the block indicators “G - Land resources, climate and biological resources.”

Regions	G - Land, Climate and Biological Resources										
	X ₁₃	X ₁₄	X ₁₅	X ₁₆	X ₁₇	X ₁₈	X ₁₉	X ₂₀	X ₂₁	X ₂₂	X ₂₃
Republic of Dagestan	0.736	0.667	0.380	0.512	0.444	0.245	0.000	0.500	0.500	0.500	0.082
Republic of Ingushetia	0.195	0.000	0.541	0.488	0.267	0.051	0.000	0.000	0.000	0.000	0.015
Kabardino-Balkarian Republic	0.218	0.000	0.769	0.419	0.689	0.170	0.500	0.500	0.500	0.500	0.177
Karachay-Cherkess Republic	0.253	0.333	0.620	0.267	0.578	0.010	0.000	0.000	0.000	0.000	0.038
Republic of North Ossetia-Alania	0.322	0.000	0.834	0.395	0.644	0.096	0.667	0.000	0.000	0.000	0.001
Chechen Republic	0.230	0.333	0.537	0.279	0.533	0.157	1.000	1.000	1.000	1.000	0.342
Stavropol region	1.000	1.000	1.000	1.000	1.000	1.000	0.667	0.667	0.333	0.667	1.000

Table 6. (continued) Standardized values of the block indicators “I-infrastructure.”

Regions	I-infrastructure															
	X ₂₄	X ₂₅	X ₂₆	X ₂₇	X ₂₈	X ₂₉	X ₃₀	X ₃₁	X ₃₂	X ₃₃	X ₃₄	X ₃₅	X ₃₆	X ₃₇	X ₃₈	X ₃₉
The Republic of Dagestan	0.674	0.069	0.694	0.377	0.333	0.685	0.320	0.264	0.656	0.333	0.737	0.750	0.144	0.712	0.226	0.653
The Republic of Ingushetia	0.742	0.074	0.755	0.716	0.814	1.000	0.970	0.440	0.813	0.814	0.851	0.143	0.060	0.744	0.743	0.227
Kabardino-Balkarian Republic	0.605	0.619	0.755	0.551	0.637	0.875	0.858	0.610	0.750	0.637	0.865	0.464	0.569	0.927	0.729	1.000

Karachay-Cherkess Republic	0.574	0.481	0.898	0.748	0.696	0.922	0.763	0.687	0.938	0.696	0.826	0.643	0.605	0.791	0.852	0.985
Republic of North Ossetia-Alania	0.632	1.000	0.816	0.690	0.637	0.809	0.639	0.648	0.781	0.637	0.939	0.429	0.760	0.944	1.000	0.937
Chechen Republic	1.000	0.058	0.898	0.665	0.291	0.922	0.414	0.242	0.844	0.291	0.816	1.000	0.240	0.858	0.231	0.239
Stavropol region	0.537	0.894	1.000	1.000	1.000	0.984	1.000	1.000	1.000	1.000	1.000	0.393	1.000	1.000	0.971	0.982

Table 6. (continued) Standardized values of the block indicators “T - Technique, technologies.”.

Regions	T - Technique, technologies													
	X ₄₀	X ₄₁	X ₄₂	X ₄₃	X ₄₄	X ₄₅	X ₄₆	X ₄₇	X ₄₈	X ₄₉	X ₅₀	X ₅₁	X ₅₂	X ₅₃
Republic of Dagestan	0.000	0.224	0.315	0.685	0.611	0.414	0.556	0.212	0.495	0.194	0.216	0.352	0.427	0.662
Republic of Ingushetia	0.000	0.980	0.108	1.000	1.000	0.730	1.000	0.981	0.846	0.709	0.455	0.687	1.000	1.000
Kabardino-Balkarian Republic	0.429	0.776	0.262	0.875	0.778	0.680	0.738	0.663	0.644	0.515	0.615	0.624	0.569	0.828
Karachay-Cherkess Republic	0.048	0.367	0.134	0.922	0.882	0.816	0.849	0.702	0.780	0.796	0.658	0.785	0.675	0.879
Republic of North Ossetia-Alania	0.095	0.653	0.169	0.809	0.780	0.695	0.744	0.538	0.727	0.641	0.545	0.742	0.615	0.784
Chechen Republic	0.190	0.041	0.344	0.922	0.586	0.441	0.564	0.231	0.508	0.233	0.247	0.392	0.709	0.674
Stavropol region	1.000	1.000	1.000	0.984	0.953	1.000	0.910	1.000	1.000	1.000	1.000	1.000	0.760	0.957

Table 6. (continued) Standardized values of the block indicators: “A - Administrative processes” and block “L - System of legislation and regulation of processes”.

Regions	A - Administrative processes							L - System of legislation and regulation of processes							
	X ₅₄	X ₅₅	X ₅₆	X ₅₇	X ₅₈	X ₅₉	X ₆₀	X ₆₁	X ₆₂	X ₆₃	X ₆₄	X ₆₅	X ₆₆	X ₆₇	X ₆₈
Republic of Dagestan	0.667	0.909	0.894	1.000	0.584	0.232	0.311	0.396	0.444	0.141	0.507	0.436	0.297	1.000	1.000
Republic of Ingushetia	0.500	1.000	0.977	0.836	1.000	0.982	0.540	0.415	0.639	0.097	0.354	1.000	0.514	0.000	0.000
Kabardino-Balkarian Republic	0.833	0.946	0.976	0.922	0.709	0.946	0.621	0.585	0.373	0.076	0.584	0.606	0.649	0.000	0.000
Karachay-Cherkess Republic	1.000	0.956	0.967	0.804	0.892	1.000	0.708	0.670	0.902	0.216	0.604	0.715	0.486	0.000	0.000
Republic of North Ossetia-Alania	0.333	0.917	0.902	0.782	0.718	0.607	0.677	0.623	0.741	1.000	0.596	0.581	1.000	1.000	1.000
Chechen Republic	0.917	0.981	1.000	0.540	0.535	0.286	0.385	0.349	0.337	0.249	1.000	0.421	0.405	0.000	1.000
Stavropol region	0.833	0.992	0.996	0.840	0.992	0.893	1.000	1.000	1.000	0.297	0.722	0.778	0.486	1.000	1.000

Table 7. Ranking the regions according to the results of digital analysis (at the regional level).

Regions	D	Rank	I	Rank	G	Rank	I	Rank	T	Rank	A	Rank	L	Rank	Multidimensional average	Rank
Republic of Dagestan	1.054	1	0.378	5	3.455	4	0.477	7	0.383	7	0.657	7	0.528	3	0.3282	6
Republic of Ingushetia	1.875	7	0.354	6	5.273	1	0.619	5	0.750	2	0.834	4	0.377	6	0.3189	7
Kabardino-Balkarian Republic	1.529	3	0.576	4	3.364	5	0.716	4	0.643	4	0.850	3	0.359	7	0.4116	3
Karachay-Cherkess Republic	1.683	5	0.588	3	4.909	2	0.757	3	0.664	3	0.904	2	0.449	5	0.3949	4
Republic of North Ossetia-Alania	1.646	4	0.603	2	4.182	3	0.769	2	0.610	5	0.705	5	0.818	1	0.4267	2
Chechen Republic	1.517	2	0.309	7	3.182	6	0.563	6	0.434	6	0.663	6	0.470	4	0.3333	5
Stavropol region	1.751	6	0.757	1	1.545	7	0.923	1	0.969	1	0.935	1	0.785	2	0.6547	1

Table 8. Results of developing a typological groups of regions of the North Caucasus Federal District according to the level of digital economy.

Interval values of typological groups		Region type	Regions	Linguistic characteristics of the typological group
I	1-0.75	A progressive level of development of the digital economy	None	The regions are characterized with the most favorable infrastructural, technological, institutional, legislative and administrative conditions for the digital transformation. There are no significant deficits that can halt the process of digital transformation.
II	0.75-0.5	An average level of the digital economy	Stavropol region	The economy is characterized with an average level of digitalization, demonstrating an uneven access to various sectors of the economy. Such regions have an accelerated digitalization in the public sector in comparison with the real sector of the economy. First of all, the export-oriented sectors of the economy undergo digital transformation, but the digitalization process is unbalanced. The technological development of digital technologies is tied to the industry specifics and the existing system for the distribution of productive forces.
III	0.5-0.25	An inert level of the digital economy	Republic of Dagestan, Republic of Ingushetia, Kabardino-Balkarian Republic, Karachay-Cherkess Republic, Republic of North Ossetia-Alania, Chechen Republic	The level of digital technology development is below the national average. A large number of deficits are clearly observed, leveling the process of digital transformation of the economy. The development of digital technology is inertial.
IV	0.25-0	Depressed regions with a critically low level of development of the digital economy	None	The region is characterized by the absence of positive practices in the application of digital technologies due to a residual principle of financing this sphere at the regional management level and a low level of economic development. The depressive state of the main sectors of the economy does not allow for a systematic policy on digital transformation.

4. Conclusion

The proposed methodological approach allows annual monitoring of digital modernization processes and the generation of relevant information for power institutions in order to develop the most optimal tools to support economic entities. The application of the methodology will make the transition from traditional modernization of agriculture to digital more operational and less labor intensive. The combination of distinctive characteristics of the developed methodology will allow to develop more effective organizational and economic regulators of the modernization process in the transition to a digital economy.

References

- [1] Teece D J 2018 Profiting from innovation in the digital economy: Enabling technologies, standards, and licensing models in the wireless world *Research Policy* **47**(8) pp 1367-1387
- [2] Bogoviz A V, Semenova E I, and Alekseev A N 2018 New challenges for regional economy at the modern stage *Advances in Intelligent Systems and Computing* **622** pp. 574-580
- [3] Demartini M, Evans S, and Tonelli F 2019 Digitalization technologies for industrial sustainability *Procedia Manufacturing* **33** pp 264-271
- [4] Alekseev A N, Lobova S V, Bogoviz A V, and Ragulina Yu V 2019 Digitalization of the Russian energy sector: State-of-the-art and potential for future research *International Journal of Energy Economics and Policy* **9**(5) pp. 274-280
- [5] Gaspareniene L, Remeikiene R, and Navickasm V 2016 The concept of digital shadow Economy: consumer's attitude *Procedia Economics and Finance* **39** pp 502-509
- [6] Watanabe C, Naveed N, and Neittaanmäki P 2018 Digital solutions transform the forest-based bioeconomy into a digital platform industry: A suggestion for a disruptive business model in the digital economy *Technology in Society* **54** pp 168-188
- [7] Pagoropoulos A, Pigosso D, and McAloone T C 2017 The emergent role of digital technologies in the circular economy: A review *Procedia CIRP* **64** pp 19-24