Assessment of Conditions and Results of Digitalization at the Meso-Level of Russian Economic System

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Abstract. Up to now, the existing rankings comparing digitalization level in economic or managerial processes at the level of national social and economic systems have been founded on the average assessment. Furthermore, they have taken into consideration neither differences in economic development of territories within one country, nor the degree and causes of inequality. The paper presents the authors' methodology to monitor and assess conditions and results of digitalization at the meso-level of Russian regional economies. The analysis revealed differences in Russian indices of digitalization and digital literacy of federal subjects of Russian Federation included in the Southern Federal District.

1. Introduction

Current trends of global and national digitalization of economy, of public and municipal management occur in commons fields such as globalization of economic relations, e-government, online and distance selling for businesses and customers, etc. Besides, they have national feature associated with a large number of factors such as historical traditions, priorities in lifestyle, culture of behavior and consumption, innovation-oriented economic policies and priority in accessibility level, national and international security systems. As a rule, these trends are reflected in national strategies and projects (for example, Strategy of the Information Society Development in the Russian Federation for 2017 - 2030 [1] and are revealed in the program draft "Digital Economy of the Russian Federation" [2]).

We conceive a national economic system as a set of meso units accumulating country`s resources and gross value added in real service and goods production and value added terms. The meso units territorially coincide with Russia`s administrative entities i.e. subjects of the Russian Federation composing federal districts. The meso units implement national strategies of digital economy taking into account regional perspective and potential.

The problem of digital inequality is one of the most important nowadays in the process of digitalization which the society is trying to overcome. This concerns technological accessibility level ensuring expansion of available services and consumption methods, and, generally, improving population`s quality of life. Development, implementation and use of digital technologies in mass production requires high financial investment and has to be consistent in order to ensure national security. Therefore, there are limits to speed and success of digitalization for emerging economies due to issues with public and business finance management. Sanctions regimes and trade "wars" only aggravate the problem of inequality and reduce accessibility of vital new technologies for population

of countries-subjects of such restrictions. Furthermore, they face inequality in fighting for competitive advantages in the global market of goods and services.

In the works of foreign and Russian researchers and practitioners ([3], [4], [5]), the definition of the modern stage of scientific and technological progress is presented. It includes R&D introduction level into mass production and consumption. This stage is defined as the fourth industrial revolution (Industry 4.0) and is referred to as the active digitalization of services, including state and municipal services. The trend enables not only to expand the market of services production and consumption, but also to efficiently introduce new digital technologies in other sectors of economic activity such as agriculture and industry. That makes it possible to automate and optimize the entire cycle of production and sales increasing its efficiency and minimizing labor load. It results in redistribution of labor resources into the service sector, retraining of personnel, changes of labor migration flows at both national and global levels.

Trends and consequences of globalization for developed and developing economies at meso-levels are to be studied taking into consideration special features including digitalization level. For many emerging economies, including the majority of African countries, the main obstacle to large-scale digitalization is low participation not only in the fourth, but also in all previous industrial revolutions. of International statistics data on GDP, living standards, industrial production indices, etc. prove this point. So do the calculation methods of the digitalization indices of the UN (e-Government Development Index [6], ICT Development Index [7]), Global Cybersecurity Index [8]) and of other international organizations (Networked Readiness Index of the World Economic Forum [9], Social Progress Index [10], etc.)

2. Materials and methods (model)

In Russia, in contrast to Germany, the State has a greater role in R&D encouragement and mass implementation of key digital technologies into social and economic processes in cities and villages. Therefore, the assessment of conditions and results of digitalization at the level of Subjects of the Russian Federation is based on the following principles:

- Data of public regional programs of information society development are analyzed along with results of their implementation. Federal program "Digital Economy of the Russian Federation" adopted in 2017 required development and implementation of similar programs of digitalization of economy in regions. The goal was to make the strategic planning and management more action-oriented and practicable, and to provide a wider range of financing opportunities. Nevertheless, in September 2018, Russian Ministry of Finance almost three times reduced the financing of this program from 3.5 trillion to 1.2 trillion rubles which had been scheduled for 2024;

- Trends of population involvement in digital programs have been monitored by Federal Service of State Statistics (Rosstat) since 2013. A selective Federal statistical observation of information technologies use and telecommunication networks introduction (ICT-2017) [11] was conducted in accordance with the Order of the Government of the Russian Federation № 2191-p dated November 26, 2012. Besides, methods and frequency of population survey also evolved. So, if in 2013 only one study in the form of Federal statistical observation №1-it was conducted, in 2017 three large-scale surveys were carried out;

- Research data and its analysis presented by such institutions as:

* Russian Association of Electronic Communications (RAEC) [12];

* Internet Research Institute [13];

* SKOLKOVO Business School Institute for Emerging Market Studies (SIEMS) [14];

* Higher school of urban studies [15];

• Regional public organization "Center of Internet Technologies" (ROCIT) [16].

This paper presents the results of the authors` method of structural analysis on the example of the subjects of the Russian Federation memebers of the Southern Federal District. The structural analysis, its details and techniques were studied in the previous works of the authors (see [17], [18], [19]).

3. Results and discussion

All available data sources on trends and features of digitalization in the course of social and economic development of territories in the subjects of the Russian Federation included in the Southern Federal District were analyzed. The studied data reflects both the expansion of digital technologies and digital literacy in population and existing threats to digital security.

3.1. Assessment of conditions and results of Russian regional digitalization trends

Content analysis of Federal and regional programs on public role in digitalization of the Russian regions reveals the following trends and problems:

- most Russian Federation subjects do not prioritize digitalization in the adopted strategies of social and economic development. The fact has led to additional requirement to work out programs for the digital development of regional economies. It should be specified that, at the meso-level, the digital economy is to be regarded as a system of social and economic relations aimed at improving its efficiency and competitiveness through the active introduction of digital technologies (Industry 4.0.) by producing and selling goods and services;

- involvement in global economy dictates objective conditions and implications of digital transformations of social and economic systems of Russian regions at meso-level. The trend is confirmed by the structure of foreign economic activities of regions and the influence of sanctions regimes, by membership of Russia in international organizations (WTO, BRICS, etc.) as well as by increasing reliance on digital systems for using and storage of large amounts of data in management, business and government decision-making;

- there is a growing demand of Russian population and business for mobile communication providing a variety of services and opportunities as well as an increase in social and corporate networks use. Digitalization and information management ensures availability of most digital technologies for residents of cities and villages of any scale and remoteness. They are applied in service, industrial and agricultural sectors. Nevertheless, certain signs of inequality (varying levels of demand) in the use of digital technologies continue to be relevant for a number of Russian regions located remotely from the most populated areas of the country;

The authors took into consideration the level of national economy as a total combination of meso-economic systems formed through accumulation of data and resources at the micro-level within certain administrative and territorial boundaries. The evaluation outcomes of the digitalization processes in Russia are presented below. The data obtained confirm that of a number of international ratings (primarily, the UN`s):

Table 1. EGDI Index Calculation Result According To Samples Of Structural Analysis In 2018.

| Countries | Position in the global rating | E-Government Development Index | | | | GNI Per Capitas (US dollars) |
		Online Service Index	Telecommunication Infrastructure Index	Human Capital Index	E-GDI 2018	
A	*B*	*1*	*2*	*3*	*4*	*5*
Japan	10	0,95	0,84	0,84	0,8783	43540
Germany	12	0,93	0,79	0,90	0,8765	49690
Russia	32	0,92	0,62	0,85	0,7969	24120
China	65	0,86	0,47	0,71	0,6811	15470
India	96	0,95	0,20	0,55	0,5669	6490
Pakistan	148	0,55	0,15	0,37	0,3566	5560
World	-	0,57	0,42	0,42	0,5491	

Source: compiled by the authors on materials of [6]

- in July 2018, the UN presented new results e-government development Index calculation. The e-Government Development Index (EGDI) has been an ingredient indicator for measuring the government readiness and ability to use information and communication technologies to provide services for population since 2001 (table.1). It should be specified that the nations` rating according to the EGDI fully coincides with levels of their economic development;

- Table 2 presents data obtained from Development Index, presented since 2007 by the International Telecommunication Union (ITU) of the UN [7] and the Networked Readiness Index of the World Economic Forum [9]). Nations ` distribution by rating values of the two indices confirms the correlation of the economy digitalization rates with the economic development type. The range varies from mainly agricultural economies for instance Pakistan to most economically developed Germany and Japan. The economic system of the United States regarding its service degree development and digital transformation is at the top of the rating.

Table 2. Economies Global Rating According To ICT And NRI Indices.

Countries	Economies global rating according to ICT Development Index		Economies global rating according to Networked Readiness Index	
	2016	2017	2015	2016
A	*1*	*2*	*3*	*4*
Japan	11	10	10 (5,6)	10 (5,6)
Germany	13	12	13 (5,5)	15 (5,6)
Russia	43	45 (-2)	41 (4,5)	41 (4,5)
China	83	80	62 (4,2)	59 (4,2)
India	138	134	89 (3,7)	91 (3,8)
Pakistan	148	148	112 (3,3)	110 (3,4)

Source: compiled by the authors on materials of [7] and [9]

According to the International Telecommunication Union (ITU), the UN ranking of countries by the value of Global Cybersecurity Index 2017 is presented, too. The difference in countries distribution in these ratings from the previous ones indicates high efficiency of public management and integration of security systems against cyber threats at the national scale in Russia. Similar situation is true for India which possesses experience in identifying and preventing terrorist threats and proactive public policy in encouragement of protective space for the use of digital technologies (see table 3);

Table 3. Economies Global Rating According To Global Cybersecurity Index 2017.

Countries	Economies global rating according to Global Cybersecurity Index in 2017	
	Position	Index value
Russia	10	*0,788*
Japan	11	0,786
India	23	0,683
Germany	24	0,679
China	32	0,624
Pakistan	66	0,447

Source: compiled by the authors based on the materials [8]

On the basis of data used by the HSE Institute for Statistical Studies and Economics of Knowledge in its statistical compendium of 2018 [20], there was compiled a table describing the changes in the number of patent applications for ICT inventions in the applicant's country (see table.4).

Table 4. Patent Activity Dynamics In The Field Of Information And Communications Technology In 2010 And 2017 On The Sample Of Countries.

Countries from a given sample	Number of patent applications for information communication technologies, units		T of growth, in % by 2010
	2010	2017	
China	42542	146723	344,9%
Japan	71164	57801	81,2%
Germany	11296	11944	105,7%
Russia	1239	1532	123,6%

Source: compiled by the authors based on the materials [20, p. 41]

It can thus be seen that in China the number of patent applications was almost 3.5 times higher at the end of the analyzed period, whereas in Russia the increase was 23.6 per cent. It should be taken into account that the average result of patent implementation is 31 per cent of the total number of developed advanced production technologies related to information and communications sphere. We can observe insufficient volume and contribution results into intellectual development of ICT among the developed nations. The situation in Japan is complex and ambiguous since it faced the reduction of more than 18.8 per cent (see table 4). This may indicate both a crisis in the growth of intellectual activity and an overloading of market with previously developed technologies against the background of their high demand and economic efficiency.

3.2. Digital transformations results in the Southern Federal district and its regions: Digitalization and Digital Literacy Indices

The authors have developed the method of structural analysis to statistical data regarding industry structure of gross value added (GVA) for subjects of the Russian Federation over the period 2004 - 2016. The following results of Russian regions distribution according to the level of economic development were achieved on the basis of an assessment of industrialization and service development level of economy at meso-leve:

- The first step of the analysis included calculation of two coordination indices t_α and t_β were using the formulas по формулам:

$t_\alpha = D_I / D_A$

$t_\beta = D_S / D_I$

where D_A is the share of the agricultural sector in the GVA structure;

D_I is the share of the industrial sector in the GVA structure;

D_S is the share of the service sector in the GVA structure.

- The second step is aimed at presenting the distribution of the subjects of the Russian Federation on the graph by the calculated values of t_α and t_β for the period of 2004-2016. Figure 1 shows a significant progress of individual regional economies towards increasing the level of industrial development (the maximum value of t_α increased from 12.1 to 22.5) and the degree of service-oriented economy (the maximum value of t_β increased from 9.6 to 17.1);

- Moscow and St. Petersburg, on the one hand, and regions specializing in extraction of mineral resources (for instance Tyumen and Arkhangelsk region), on the other hand, are further excluded from the aggregated distribution. Consequently, the analyzed sample is concentrated on typical social and economic characteristics of the Russian territories which are grouped in Fig.2 according to t_α and t_β values exceeding 1.

a) according to 2004 data   b) according to 2016 data
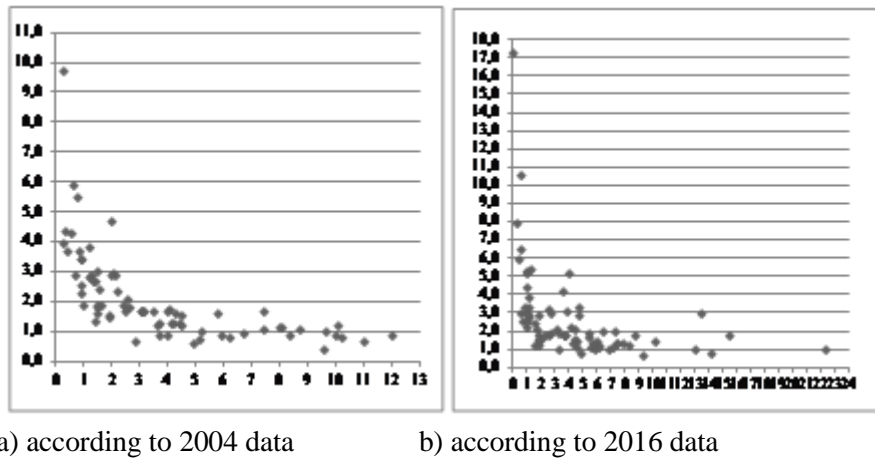
Figure 1. Distribution of subjects of the Russian Federation according to t_α and t_β values in 2004-2016. Source: compiled by the authors on materials of Russian Federal Service of State Statistics [21].
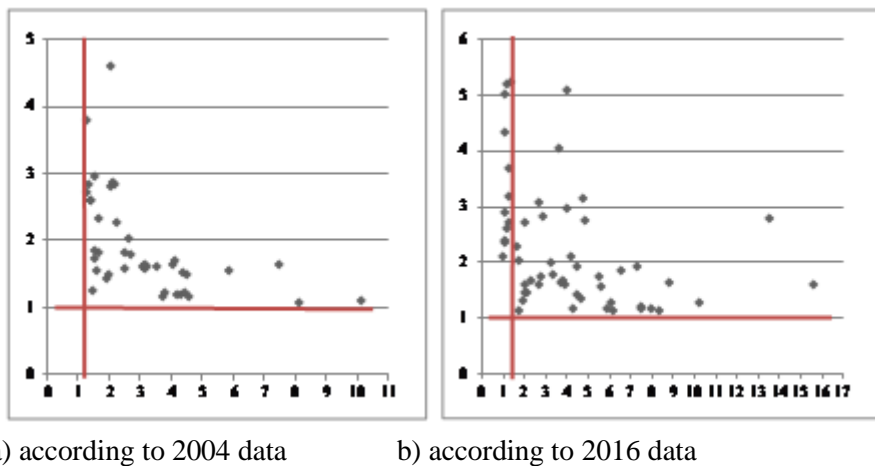

a) according to 2004 data   b) according to 2016 data

Figure 2. Distribution of subjects of the Russian Federation according to t_α and t_β values exceeding 1 in 2004-2016. Source: compiled by the authors on materials of Russian Federal Service of State Statistics [21].

It could be argued that there is a positive trend in the economic development of regional economies due to the increased number of subjects of the Russian Federation with tα and tβ values exceeding 1. This indicates the evolution with positive trends of service-oriented and industrialization of economy;

- At the next step of graphical analysis (see Fig.3) a new limiting condition it was set. A sample of Russian regions with tα and tβ values exceeding 2 was compiled. It should be noted that in 2004 there were only 5 such regions in the Far-Eastern Federal District and the Siberian Federal District (excluding federal cities and so called "raw materials" regions), in 2016 the number increased up to 9 regions (see table.5).

The authors make the following conclusions as a result of the application of the authors' method of structural analysis to the subjects of the Russian Federation in order to identify the trend of digitalization. First of all, there is a certain correlation in the trend of increasing service-oriented economy level on the background of a high level of industrialization (according to tα and tβ values exceeding 2). The reason is that a high level of service-oriented economy indicates the presence of necessary infrastructure and market for digital technologies. Secondly, the number of regions with a harmonious combination of tα and tβ values in Russian regions is small, despite the large number of territories with high values of either tα or tß evolving towards the trend of servicing (and digitalization), although the authors have revealed a tendency of their increase (see table.5).
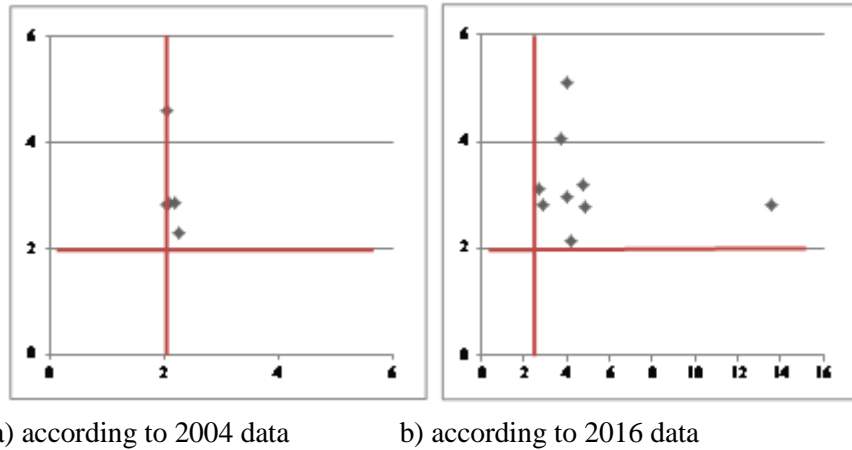
a) according to 2004 data   b) according to 2016 data

Figure 3. Distribution of subjects of the Russian Federation according to t_α and t_β values exceeding 2 in 2004-2016. Source: compiled by the authors on materials of Russian Federal Service of State Statistics [21].

Table 5. Sample Of The Subjects Of Russian Federation According To t_α And t_β Values Exceeding 2 In 2004-2016.

Period	min. t_α	max. t_α	min. t_β	max. t_β	List of subjects of the Russian Federation
2004 год	2,1	2,3	2,3	4,6	the Chukotka Autonomous Region, Amur Region, Republic of Buryatia, Novosibirsk region, The Zabaikalye Territory
2016 год	2,7	13,6	2,1	5,1	Ivanovo Region, Moscow Region, Tver region, Sevastopol, Rebuplic of Buryatia, Rebuplic of Tyva, Novosibirsk region, Zabaikalsky Territory Khabarovsk Territory

Source: compiled by the authors on materials of Russian Federal Service of State Statistics [21]

At the next stage of analysis of trends in digitalization, the authors analyzed the existing ratings of digital literacy and digitalization which are calculated in separate Federal districts and subjects of the Russian Federation:

1) One of the available and having a history of data collection is Rosstat (ICT-2017), from the available system of indicators the authors have focused on two:

- E-Commerce development in form of delivery orders of goods and/or services: according to the data of 2017 on the example of the Southern Federal District, it can be concluded that there are regions: 1) where there is no strong difference in this indicator (the Republic of Kalmykia and the Republic of Adygea) due to the lack of sharp difference in the living standards of urban and rural residents and 2) where the agricultural sector in the economy dominates (Fig. 4);
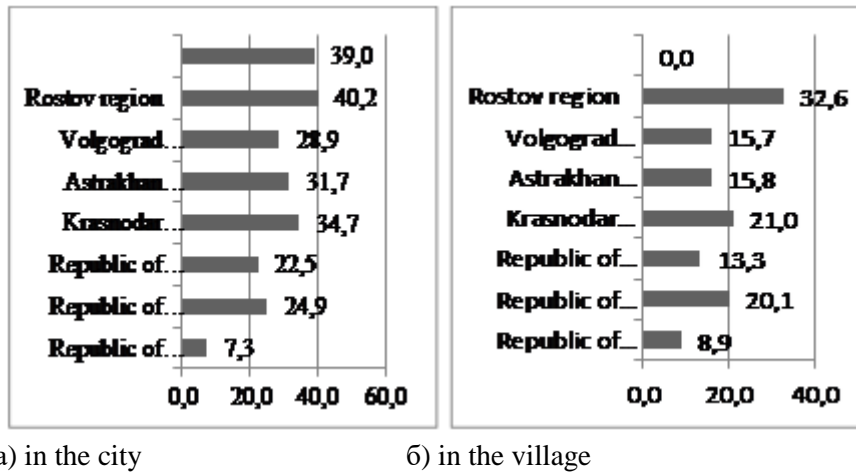
a) in the city   б) in the village

Figure 4. Population of the Southern Federal District involvement in e-commerce of goods and / or services as a percentage of the total population aged 15-74 in subjects of the Russian Federation. Source: compiled by the authors on materials of Russian Federal Service of State Statistics [11].

Figure 5 presents the results of collected data concerning the population group (aged 15-74) which has an electronic signature. The value varies from 0.3% to 6.4%, which can be explained by both quality of life differences and the degree of population involvement in business and entrepreneurial activity;
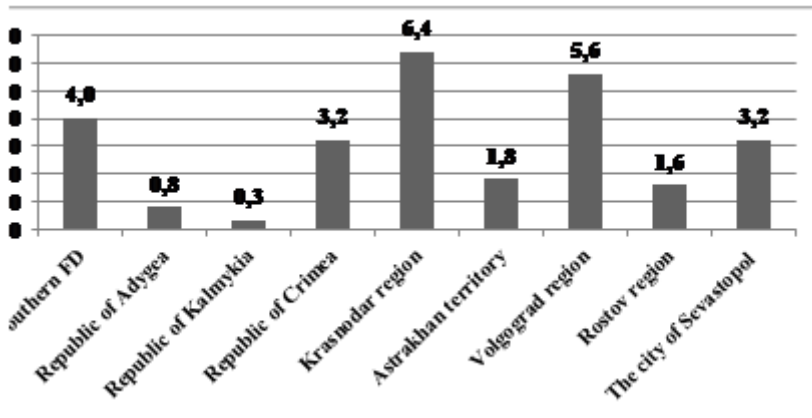

Figure 5. Population of the Southern Federal District having an electronic signature, registered on the federal integrated portal for state and municipal services, on the regional portal for state and municipal services in the subjects of the Russian Federation including in the South Federal District, as a percentage of the total population aged 15-74 in subjects of the Russian Federation. Source: compiled by the authors on materials of Russian Federal Service of State Statistics [11].

- Digital Life of Russian Megapolises (Skolkovo, Institute of Emerging Markets Skolkovo (IEMS) conducted a study in 15 million-plus major cities based on the criteria of seven digitalization areas and the grade of correlation between supply and demand for digital technologies in finance, media, trade, transport, education, health, administration (urban management) [14];

The Regional public organization " Center of Internet technologies" (RCIT) conducted a federal research and determined "Digital literacy Index" which includes three sub-indices: digital consumption, digital skills and digital security [16].

Table 6 presents the main results of these two digitalization indices in Russia which allow to assess the difference in the results of digitalization at the level of Federal districts and million-plus cities.
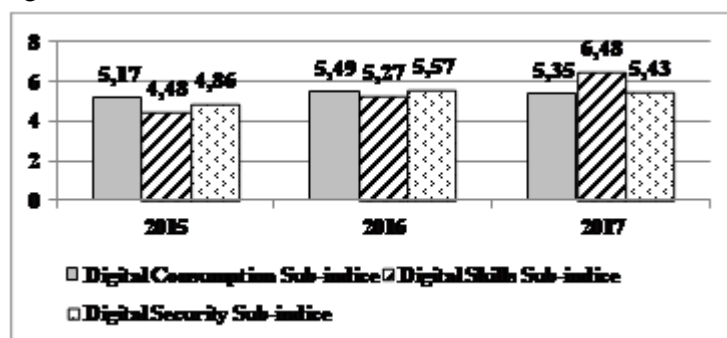
Table 6. Distribution of subjects of the Russian Federation and million-plus cities according to Digitalization Indices.

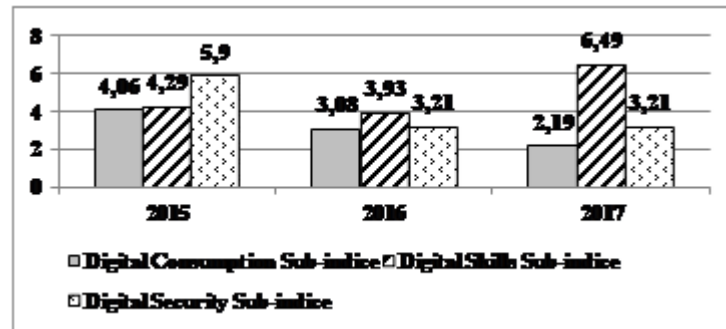| Federal District *	Cities	Digital life of cities (Skolkovo)		Digital Index		Literacy
		2014	2015	2015	2016	2017
A	*Б*	*1*	*2*	*3*	*4*	*5*
Ural FD	Yekaterinburg г	1	1	5,02	5,07	5,07
	Chelyabinsk	7	11			
Northwest FD	St. Petersburg	2	2	6,46	6,39	5,95
Central FD	Moscow	3	3	5,83	6,78	6,41 (max.)
	Voronezh	13	15			
Volga FD	Kazan	8	4	3,3	4,42	4,42
	Nizhny Novgorod	10	8			
	Perm	4	7			
	Ufa	11	9			
	Samara	5	12			
Siberian FD	Novosibirsk	9	5	3,97	3,71	5,03
	Krasnoyarsk	6	6			
	Omsk	14	13			
Southern FD	Rostov-on-Don	12	10	4,72	3,47	4,28
	Volgograd	15	14			
Far Eastern FD	-	-	-	5,17	4,17	4,17 (min.)
North Caucasus FD	-	-	-	4,19	4,47	4,4
In the whole of the Russian Federation				4,79	5,42	5,99

* FD referrers to Russian Federal District
Source: compiled by the authors on the materials of two indices [14] and [16]

The example of the Southern Federal District shows that Skolkovo rating includes 2 cities from the Southern Federal District (Volgograd and Rostov-on-Don). The level of digitalization in them is improving at a small rate, despite the fact that Volgograd in 2014 was on the last position of the top 15 cities according to «Digital Life of Cities" index.

a) In the whole of the Russian Federation

б) In the Southern Federal District

Figure 6. Russian digital literacy sub-indices fluctuation in the Southern Federal District for 2015-2017. Source: compiled by the authors on the materials of the indices [16].

The Figure 6 shows the comparison of the values of subindexes as components of the digital literacy index in the Russian Federation and in the Southern Federal District for 2015-2017. The graph proves that the most critical value in the decline for the Southern Federal District was that of the digital security sub-index (due to the fact that compared to the all-Russian value for the SFD there was no increase in the indicator of compliance with ethical standards when placing digital content and there are no changes in improving attitude of people to pirated software, (as in the Ural Federal District), but the value sub-index of the digital competence evidently increased what is explained by increase of the trust and popularity of financial transactions online and of the purchasing goods and services in online shops.

4. Conclusion

The authors have come up with the given below conclusions having conducted analysis of numerious factors including impact of economic globalization, increasing relevance of security of economic systems and digital technologies, growing demand of the participants of social and economic relations for products and services of the digital economy:

It was revealed that the level of digitalization of the economy is closely correlated with the degree of its service-orientation when the structure of gross value added is dominated by the service sector. Nevertheless, this does not mean that the agricultural and industrial sectors are degrading. The condition for successful digital development of the economy is the preservation and growth of labor productivity in these sectors. The exception is the sphere of public and municipal services where the success of the introduction of digital technologies does not depend on the state of the economic development, but on the effectiveness of public policy implementation. The study provides an example of the international Global Cyber security Index which positions Russia ahead of Japan and other countries in the studied sample;

- At the meso-level of the national economic system, main features and trends of digital development were identified and analyzed. The comparative study of the subjects of the Russian Federation proves the growth of service integration into the economy structure (including digital services) since 2004. The obtained results reveal a general positive trend of service-orientation of economy in the subjects of the Russian Federation, as well as positive changes towards accessibility of digital technologies across Russian territories of various administrative status and scale.

5. Acknowledgment

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