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The 'Digitalisation trap' of Russian regions

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Abstract: The purpose of the study is to identify the 'digitalisation trap' of regions as the cause of Russia's digital lag in the global world order. The authors identified the structural components of the 'digitalisation trap' of Russian regions: existing digital gaps between regions resulting from different levels of digital infrastructure formation, gaps in the implementation of opportunities for long-term development of regions using digital technologies, as well as inefficient regional digitalisation policies. The authors proposed a methodology for assessing the structural components of the 'digitalisation trap'. The calculation of the overall integral indicator of the effectiveness of regional digital development allowed the authors to rank the regions of Russia and propose effective measures to overcome the 'digitalisation trap'. The author's methodology for assessing the 'digitalisation trap' of regions can be used to improve the state policy of digital development in developing countries.

Keywords: digitalisation; region; digitalisation trap; digital gaps; regional policy; Russia.

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1 Introduction

Digital technologies have become widespread all over the world and have provided ease and convenience of communication, accelerated operations, and increased opportunities for obtaining goods and services. However, according to the World Bank, the effect of using digital technologies in the form of digital dividends (accelerating economic growth, increasing the number of jobs, improving the quality and availability of services, etc.) is distributed unevenly in the global space (World Bank, 2016).

For example, US, China, and the European Union (Great Britain, Germany, Italy, France, and Sweden) are the leaders of digital development at present, while Russia is 1.5–3 times behind these countries in terms of the share of the digital economy in GDP (McKinsey, 2017).

In addition, some countries and regions have features of the first wave of digitalisation (business management information systems, telecommunications technologies), while others are already successfully implementing third-wave technologies (robotics, 3D printers, artificial intelligence, machine learning) (Katz, 2017).

The probable reasons for Russia's digital lag are associated with the scale of the country's territory, which determines differences in access to the internet and digital technologies, as well as specific economic conditions and limited government funding. However, the study of digitalisation processes in the territorial context allows the authors to make an assumption about the existence of factors that cause significant gaps in digital development between the regions of Russia. These factors are not taken into account in the process of public administration and therefore limit the ability of regions to achieve the effects of digital growth.

2 Theoretical basis of the research

The research hypothesis is based on publications that reflect the nature and dynamics of digitalisation in various regions of the world and allow authors to trace the logic of digital transformations.

Varian et al. (2002), Gillett et al. (2006), Jonscher and Tyler (1982) argued that computer, broadband, and mobile phone networks played an important role in easing scalability constraints and identified opportunities for business expansion, meeting additional end demand and increasing labour demand, as well as faster growth in traditional economic sectors in US, Great Britain, France, Germany, and Kenya.

Crandall et al. (2007) determined that the impact of broadband on job creation in US is more concentrated in the service sector (for example, financial services, education, healthcare, etc.), but a positive effect was also found in the manufacturing sector. Atkinson et al. (2009) pointed to the innovative effect of the spread of internet platforms and the development of cloud computing in US in the form of creating jobs in the production, distribution and management of the digital industry of local content, strengthening national cultural identity, reducing foreign trade imbalances and stimulating demand for local ICT infrastructure services.

The introduction of artificial intelligence technologies, machine learning, as well as tools for robotisation and automation of routine tasks in enterprises and government is progressing rapidly in both mature and developing economies (International Federation of Robotics, 2016).

Martin (2005), Hedgerstrand (1966) and Sologubova (2018) note in their research that the reason for the country's digital lag is to be found in the uneven access to the internet and the use of digital technologies in the territorial context. In this case, there are digital gaps described by Novak and Hoffman (2000), Wilhelm and Thierer (2000).

Elokhov and Alexandrova (2019), Kapranova (2018), Basaev (2018), Shvetsov (2014) emphasise that bridging the digital gap will eliminate imbalances in the resource capabilities of regions and ensure an increase in the level of digitalisation of the Russian national economy.

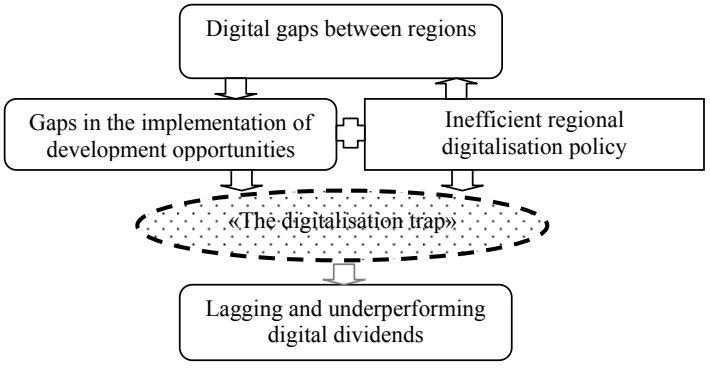
Stiakakis et al. (2010), Howard et al. (2001), Rogers (1995) and Hargittai (2002) point to the emergence of a second level of gap between countries and regions – gap in knowledge and development opportunities.

Greenstein and Prince (2006) and van Ark (2015) describe how digital gap and gap in development opportunities provoke digital inequality in countries.

3 Research methods

The authors understand the 'digitalisation trap of regions' as a complex phenomenon, its structural elements are shown in Figure 1.

Figure 1 The 'digitalisation trap' of regions



The author's hypothesis was justified in several stages:

I Selection of initial private indicators for evaluating the process of digitalisation of regions and dividing them into groups depending on their functionality (Table 1).[1]

II Calculation of 3 integral indicators for each functional group.

The authors suggest using the following method (based on the distance method):

1 Comparison and ranking of regions for each indicator (X_i) with a conditional reference region that has the best results for all compared indicators (X_{max}) (Sheremet, 2006). The definition of standardised indicators (x_i) in relation to the reference indicator is made using the formula:

$$x_i = X_i/X_{max} \quad (1)$$

2 Each of the three integral indicators is calculated using the following formula:

$$I = \sqrt{\sum_{1}^{i}(1-x_i)^2} \tag{2}$$

where

x_i: standardised indicators that reflect the digitalisation process of regions, $i = 1, \ldots, 10$.

Thus, the authors get three integral indicators:

- I_1-an integral indicator of the formation of the digital infrastructure of the region (based on standardised indicators x_1–x_3)
- I_2-an integral indicator of the implementation of the region's capabilities using digital technologies (based on standardised indicators x_4–x_8)
- I_3-an integral indicator of the effectiveness of the region's digitalisation policy (based on standardised indicators x_9–x_{10}).

The authors obtain the value of the digital gap, the gap in the realisation of development opportunities, and the gap in the implementation of an effective regional digitalisation policy based on the calculation of the scale of variation (the difference between the maximum and minimum values of the integral indicator).

III The authors determine the rating of each analysed region depending on the value of the overall integral indicator of digital development efficiency (I_{edd}), which is determined by the formula (the method of the sum of places) (Vasilyeva, 2017):

$$I_{edd} = \sum_{1}^{i} v_i * I_i \tag{3}$$

where

v_i: the coefficient of significance of the ith indicator obtained using the expert method of Delphi.

The authors rank regions into two groups:

1 regions that are in the digitalisation trap

2 regions that have overcome the digitalisation trap.

The range of variation, the average, the oscillation coefficient (the proportion of the range of variation of a random variable in the average value), and the median are calculated for ranking regions.

IV Establishing the strength and quality of the relationship between integral indicators and determining the nature of their mutual influence based on the calculation of correlation coefficients (using the MC Excel). The strength of the connection is estimated using the Chaddock scale (Chaddock, 1925), and the Kaminsky scale (Kaminsky, 1959) is used to determine the quality of the connection.

The research is based on international reports and statistics from the World Bank, the Organisation for economic cooperation and development (OECD), the Federal state statistics service of the Russian Federation, the McKinsey Global Institute, the International Telecommunications Union, the United Nations, as well as the IMD center.

Table 1 Initial indicators for evaluating the digitalisation process of regions

Group		*Indicator*
1	Indicators of the formation of the digital infrastructure of the region	• Percentage of households with a personal computer, % (X_1) • Percentage of households with broadband internet access, % (X_2) • Organisations with broadband internet access, % (X_3)
2	Indicators of implementation of the region's opportunities using digital technologies	• Users of the internet among households in the region, % (X_4) • Business digitalisation index in the region (calculated based on the share of organisations that use broadband internet, cloud services, RFID technologies, and ERP that sell using special tools, % (X_5) (Abdrakhmanova et al., 2019) • Percentage of households in the region shopping online, % (X_6) • Percentage of households in the region receiving public services online, % (X_7) • Regional human development index, % (X_8) (Analytical center under the government of the Russian Federation, 2019)
3	Indicators of the effectiveness of the region's digitalisation policy	• Index of socio-economic conditions of innovation activity in the region (aggregated assessment of economic, educational and digital development, demonstrating the potential for creating, mastering and implementing innovations in the region) (X_9) (Institute for statistical studies and Economics of knowledge HSE, 2019) • Regional expenditures on information and communication technologies (ICT), million rubles (X_{10})

4 Results

Cross-country comparisons of indicators reflecting the intensity and dynamics of the digitalisation process are important for an objective assessment of Russia's place in the world. According to estimates of the McKinsey Global Institute, the potential economic effect of using digital technologies in Russia could increase the country's GDP by 4.1–8.9 trillion rubles by 2025 (in 2015 prices), while currently it is only 3.9 % of GDP and lags behind developed countries and China by several times (for example, the size of the US digital economy is 10.9% of GDP (McKinsey, 2017), China-10%, and the European Union-8.2% (Ushakova and Uskov, 2019).

Various indices are used to compare countries in terms of digitalisation, including the ICT development Index (Russia ranks 45th) (International Telecommunication Union,

2017), the E-government development Index (Russia ranked 32nd, primarily due to a significant increase in the online services Index in 2018) (United Nations, 2018), the International digital competitiveness index (Russia is 40th out of 63 countries) (IMD, 2019), and others.

Russia's significant lag behind the leading countries limits the ability to receive digital dividends. Of course, the reason for the country's lag can be explained by the specifics of Russia's spatial development, which is due to the fact that the state has 85 regions (Federal subjects) that have a significant differentiation in terms of socio-economic development (Abdrakhmanova et al., 2019). However, according to the authors, the reason for Russia's digital lag is the "digitalisation trap of regions".

The authors argue that the 'digitalisation trap' has the following structure.

The first component is the different level of availability of necessary equipment and the formation of a digital infrastructure that provides access to the internet and digital technologies (Molchan et al., 2019; Karpunina et al., 2020). The availability of computers and alternative access via TVs or mobile phones, as well as access to the internet in accordance with the OECD methodology, are so-called 'digital readiness' indicators. The authors estimate this component of the digitalisation trap using three indicators (percentage of households with a personal computer; percentage of households with broadband internet access; organisations with broadband internet access), combined in the group "indicators of the formation of digital infrastructure in the region".

According to the Federal state statistics service of the Russian Federation in 2018, the five regions with the highest share of households that had a personal computer include the Yamalo-Nenets Autonomous okrug (96.5%), Khanty-Mansi Autonomous okrug – Yugra (86.1%), Saint Petersburg (86%), Moscow (85.5%), and the Chukotka Autonomous okrug (83.2%). Tyva Republic (57.5%), Mari El Republic (56.5%), Adygea Republic (56.1%), Jewish Autonomous oblast (55.3%), Dagestan Republic (47.8%) have the lowest indices. According to the data, the amplitude of the indicator of personal computer availability in households between the regions of the Russian Federation in 2018 was 2.02 times, while in 2014 it was at the level of 1.96 times (Federal state statistics service of the Russian Federation, 2019).

In terms of household internet access, the situation is as follows: the range of values for household internet access between regions increased from 1.3 times in 2014 to 1.6 times in 2018. The regions of the Russian Federation with the highest rates of broadband internet access in 2018 are: Yamalo-Nenets Autonomous okrug (96.3%), Khanty-Mansi Autonomous okrug – Yugra (88.9%), Tyva Republic (87.4%), Saint Petersburg (84.7%), and the Altai Republic (84.4%). Chechen Republic (50.2%), Khakassia Republic (54.5%), Dagestan Republic (58.8%), Chukotka Autonomous Okrug (59.1%), and Sakha Republic (Yakutia) (62%) have the lowest indicators (Federal state statistics service of the Russian Federation, 2019). Thus, the gap between the regions of the Russian Federation in terms of broadband access of households to the internet is 1.9 times in 2018 (3.3 times in 2014).

The OECD explains that household access to the internet and computer availability depend on two variables: income and education (OECD, 2001). Other variables such as household size and type, age, gender, racial and linguistic origin, and location also play an important role (for example, internet access is more widespread in cities than in rural areas) (Gillett et al., 2006). Differences in access to a personal computer and the internet by household income are very large and tend to growth further, but access in lower-income groups is also increasing (Varian et al., 2002; Novak and Hoffman, 2000;

Wilhelm and Thierer, 2000). In addition, people with a high level of education have more incentives to access ICTs (Varian et al., 2002; Jonscher and Tyler, 1982).

The Russian Federation has made significant progress in spreading broadband internet access, but there is still a significant gap between regions in terms of broadband internet access in organisations-1.6 times in 2018. At the same time, the size of this gap has decreased by 2.2 times since 2010, which indicates that the regions of the Russian Federation are aligned according to this indicator.

According to the OECD definition, the current situation is described by the term 'digital divide', that is, the gap between individuals, households, businesses and geographical areas at various socio-economic levels in terms of their ability to access digital technologies and use the internet (OECD, 2001). The analysis allows the authors to conclude that there are significant digital gaps between the regions of Russia at the level of population, households, and organisations (Shvetsov, 2014). Certain indicators of access to information and communication technologies and the internet have a positive trend of reducing the digital gap. This may be due to the adoption of the "Digital economy of the Russian Federation" program in 2017, as well as the development and implementation of numerous regional-level programs (Ushakova and Uskov, 2019).

The second component of the 'digitalisation trap' is revealed through the implementation of regional development opportunities using digital technologies.

Stiakakis et al. (2010) pointed out that the emergence of gaps in access to and use of digital technologies provokes a gap in knowledge and development opportunities. The experience of previous use of the internet probably affects the actions of users in the network (Howard et al., 2001), the amount of knowledge that they will acquire through digital technologies, as well as the quality of skills that will be formed. People who have access to the internet and have the appropriate skills are easier and faster to find information and are more willing to explore a new environment (Rogers, 1995). The ability of people to find the necessary content on the internet is used by them to expand their own opportunities for acquiring knowledge, education and human development, while maximising the benefits of the digital environment (Hargittai, 2002).

Thus, the effects of human capital, multiplied in terms of technically and economically secure access to digital technologies, remove hierarchical, subsidiary, and probabilistic restrictions on regional development: they equalise the possibilities of using electronic resources to realise the potential of citizens, allow them to use online services of government agencies to obtain personal information and conduct economic activities, and promote their promotion to the external environment (World Bank, 2016). Therefore, human capital in the digital environment becomes the most important determinant of the socio-economic development of the region and determines the possibility of obtaining more regional income and increasing the productivity of regional organisations (Hagerstrand, 1956; Hargittai, 2002; Greenstein and Prince, 2006). The second component of the 'digitalisation trap' of region is estimated by the authors using the following indicators for the implementation of the region's capabilities using digital technologies: internet users among households; business digitalisation index (Abdrakhmanova et al., 2019); percentage of households shopping online; percentage of households receiving public services online; human development index.

The third component of the 'digitalisation trap' is an inefficient regional digitalisation policy. To evaluate it, the authors use two indicators: index of socio-economic conditions of innovation activity (Institute for statistical studies and Economics of knowledge HSE, 2019) and regional expenditures on information and communication technologies

(Federal state statistics service of the Russian Federation, 2019). For example, the cost of ICT in 2018 in the Russian regions that occupy the top positions in terms of access to and use of ICTs is thousands of times higher than similar costs in the outsider regions. The amount of government funding for ICT costs in Russia is 2 times lower than in European countries and 2.5 times behind US. Also, the system of co-financing costs by the business sector is not developed, as in China (McKinsey, 2017). Therefore, the digitalisation policy implemented in certain regions of the Russian Federation cannot be considered effective.

The authors presented the calculation of integral indicators of the regional digital development in accordance with the proposed methodology in Table 2.

The authors define the digital gap between regions using a variation range of the integral indicator of the formation of digital infrastructure in the regions, it is 0.453. The gap in the opportunities for development of regions equal to 0.83, which confirms the author's hypothesis that digital gaps reinforce the gaps between the regions in the implementation of development opportunities. The gap between regions in terms of the effectiveness of the digitalisation policy is 1.14, which indicates that the implemented policy is ineffective in most regions of the Russian Federation.

Moscow has the best value of the integral indicator of the digital development efficiency – 0.16, the Dagestan Republic has the worst value of the indicator – 0.975.

The range of variation = 0.975–0.161 = 0.814

The average = 0.757

The oscillation coefficient = 0.814/0.757 = 107.6

The authors ranked the regions into two groups (the median is calculated to determine the range of indicators):

- regions that have overcome the 'digitalisation trap' – values of the overall integral indicator of the region's digital development efficiency is 0.161–0.568 (Moscow, Moscow region, Tyumen region, Khanty-Mansi Autonomous okrug, Yamalo-Nenets Autonomous okrug)
- regions that are in the 'digitalisation trap' – values of the overall integral indicator of the region's digital development efficiency is 0.568–0.975 (all other regions of the Russian Federation).

Indeed, the regions of the first group are characterised by a high level of use of the potential of digital technologies in all aspects of national economic activity, business processes, products, services and approaches to decision-making in order to modernise the socio-economic infrastructure. This is evidenced by official open sources (websites of municipalities, official documents, etc.), as well as the most popular media.

In particular, the leadership of Moscow is based on the continuous improvement of the regional program 'Information City', since 2012. In addition, Moscow is actively working with the federal center, its representatives are members of expert groups established under the 'Digital Economy'. A number of technological areas that are provided for in the federal program "Digital Economy of Russia" are already being tested in practice in Moscow (Kostyleva, 2018).

Table 2 Calculation of integral indicators of the regional digital development, 2018

Region	*Percentage of households with a personal computer*	*Percentage of households with broadband internet access*	*Organisations with broadband internet access*	*Users of the internet among households in the region*	*Business digitalisation index in the region*	*Percentage of households in the region shopping online*	*Percentage of households in the region receiving public services online*	*Regional human development index*	*Index of socio-economic conditions of innovation activity in the region*	*Regional expenditures on information and communication technologies (ICT)*	*Integral indicator of the formation of the digital infrastructure of the region I_1*	*Integral indicator of the implementation of the region's capabilities using digital technologies I_2*	*Integral indicator of the effectiveness of the region's digitalisation policy I_3*	*Overall integral indicator of digital development efficiency I_{edd}*
Belgorod region	66.7	68.9	91.2	79	29.0	41.1	69.2	0.906	0.39	4567	0.425	0.438	1.036	0.673
Bryansk region	67.2	64.3	87.8	77.8	26.0	21.4	54.4	0.844	0.34	5952	0.461	0.806	1.068	0.808
Vladimir region	66.8	66.1	92.7	79.2	27.0	28.3	70	0.851	0.39	4322	0.442	0.629	1.037	0.736
Voronezh region	76.6	73.7	88.6	80.6	29.0	16.7	67.6	0.882	0.45	5648	0.326	0.786	1.012	0.739
Ivanovo region	63.6	63.7	87.1	84.5	27.0	33.1	64.8	0.827	0.31	1708	0.493	0.577	1.093	0.758
Kaluga region	73.9	70.3	87.3	76.5	28.0	16.2	66.6	0.874	0.401	8966	0.373	0.813	1.027	0.767
Kostroma region	64.4	67.6	80.9	78.4	23.0	26.7	37	0.849	0.353	1810	0.479	0.881	1.061	0.832
Kursk region	66.7	76.8	78.5	83.2	26.0	32.1	62.6	0.879	0.396	3207	0.418	0.604	1.036	0.721
Lipetsk region	70.7	73.2	94.6	85	28.0	24.5	71.8	0.886	0.348	4163	0.361	0.651	1.062	0.728
Moscow region	81.7	78.3	88.2	92.8	30.0	37.8	86.2	0.882	0.398	147654	0.261	0.393	0.884	0.549
Orel region	68.7	65.7	84.6	71.7	25.0	22.1	43.3	0.869	0.411	1828	0.449	0.885	1.03	0.812
Ryazan region	68.9	65.2	87.7	72.9	27.0	14.4	54.5	0.871	0.399	3176	0.443	0.904	1.034	0.818
Smolensk region	71.1	71.8	88.6	80.2	24.0	26.9	75.2	0.851	0.397	2530	0.378	0.663	1.036	0.726

Table 2 Calculation of integral indicators of the regional digital development, 2018 (continued)

Region	*Percentage of households with a personal computer*	*Percentage of households with broadband internet access*	*Organisations with broadband internet access*	*Users of the internet among households in the region*	*Business digitalisation index in the region*	*Percentage of households in the region shopping online*	*Percentage of households in the region receiving public services online*	*Regional human development index*	*Index of socio-economic conditions of innovation activity in the region*	*Regional expenditures on information and communication technologies (ICT)*	*Integral indicator of the formation of the digital infrastructure of the region I_1*	*Integral indicator of the implementation of the region's capabilities using digital technologies I_2*	*Integral indicator of the effectiveness of the region's digitalisation policy I_3*	*Overall integral indicator of digital development efficiency I_{edd}*
Tambov region	71.9	74.5	95.2	81.7	30.0	23.5	63.9	0.867	0.418	2606	0.342	0.693	1.026	0.721
Tver region	68.9	65	83.8	82.4	23.0	23.4	40	0.851	0.316	436	0.456	0.888	1.083	0.836
Tula region	84.6	81.1	85.6	85.8	27.0	30.1	75	0.867	0.416	5502	0.236	0.567	1.024	0.651
Yaroslavl region	64.3	63.3	90.1	79.4	29.0	24.7	69.2	0.879	0.422	4284	0.485	0.664	1.023	0.754
Moscow	85.5	82	95.1	91.3	35.0	43.4	69.7	0.96	0.552	912417	0.189	0.348	0	0.161
Karelia Republic	71.6	74.6	88.6	82.6	26.0	32.4	41.1	0.86	0.345	2151	0.355	0.751	1.066	0.758
Komi Republic	75.5	77.3	88.3	81.1	26.0	31.7	49.3	0.893	0.361	7216	0.309	0.695	1.052	0.722
Arkhangelsk region	73.4	69.7	83.9	79.4	25.0	31	65.5	0.89	0.399	4941	0.392	0.624	1.032	0.718
Vologda region	73.5	69.3	86.1	79.8	26.0	24.9	60.9	0.869	0.39	7665	0.387	0.718	1.036	0.746
Kaliningrad region	68.7	70.5	88.5	82.4	28.0	27.9	65.8	0.874	0.42	3417	0.405	0.630	1.026	0.721
Leningrad region	77.1	73.2	93.9	81.9	30.0	30.8	57.4	0.862	0.29	6124	0.315	0.626	1.101	0.723
Murmansk region	75.5	82.4	87.4	88.9	26.0	41.7	45.6	0.869	0.4	4684	0.282	0.614	1.034	0.682
Novgorod region	81.3	63.4	85	75.5	27.0	26.3	48.3	0.867	0.32	2334	0.398	0.776	1.086	0.786

Table 2 Calculation of integral indicators of the regional digital development, 2018 (continued)

Region	*Percentage of households with a personal computer*	*Percentage of households with broadband internet access*	*Organisations with broadband internet access*	*Users of the internet among households in the region*	*Business digitalisation index in the region*	*Percentage of households in the region shopping online*	*Percentage of households in the region receiving public services online*	*Regional human development index*	*Index of socio-economic conditions of innovation activity in the region*	*Regional expenditures on information and communication technologies (ICT)*	*Integral indicator of the formation of the digital infrastructure of the region I_1*	*Integral indicator of the implementation of the region's capabilities using digital technologies I_2*	*Integral indicator of the effectiveness of the region's digitalisation policy I_3*	*Overall integral indicator of digital development efficiency I_{edd}*
Pskov region	68	65	87.8	78.8	26.0	26.1	39	0.828	0.35	1385	0.451	0.848	1.064	0.815
Saint-Petersburg	65.5	84.7	94.2	92.6	33.0	38.9	58.6	0.936	0.52	71996	0.345	0.479	0.923	0.616
Adygea Republic	71.8	76.2	89.1	77.7	28.0	8.1	69.4	0.842	0.31	905	0.342	0.93	1.092	0.818
Kalmykia Republic	56.1	62.1	77.5	85.8	21.0	22.2	61.5	0.853	0.31	411	0.587	0.799	1.088	0.851
Crimea Republic	63.9	81.4	87.8	84.5	28.0	18	41.4	0.831	0.34	7269	0.385	0.905	1.062	0.812
Krasnodar region	80.5	63	87.8	84.3	27.0	28.5	66.6	0.879	0.36	22961	0.397	0.621	1.035	0.719
Astrakhan region	63.3	80.8	88.5	82.6	27.0	26.5	58.9	0.886	0.43	3055	0.391	0.689	1.019	0.732
Volgograd region	80.7	76	78.8	82	23.0	25.9	70.4	0.867	0.4	7535	0.329	0.695	1.031	0.72
Rostov region	72.6	78.1	88.5	85	24.0	37.8	66.1	0.869	0.4	12457	0.326	0.539	1.025	0.669
Sevastopol	76.6	79.2	90.1	86.5	19.0	39	51.7	0.832	0.36	1729	0.283	0.702	1.060	0.719
Dagestan Republic	62	58.8	62	82.2	18.0	13.1	38.3	0.844	0.24	1367	0.643	1.079	1.147	0.975
Ingush Republic	47.8	78.1	93	78.5	33.0	14.2	64.5	0.833	0.33	522	0.541	0.837	1.08	0.845
Kabardino-Balkar Republic	73.8	66.7	79.6	84.9	24.0	17.6	67.7	0.826	0.36	597	0.429	0.81	1.059	0.795

Table 2 Calculation of integral indicators of the regional digital development, 2018 (continued)

Region	*Percentage of households with a personal computer*	*Percentage of households with broadband internet access*	*Organisations with broadband internet access*	*Users of the internet among households in the region*	*Business digitalisation index in the region*	*Percentage of households in the region shopping online*	*Percentage of households in the region receiving public services online*	*Regional human development index*	*Index of socio-economic conditions of innovation activity in the region*	*Regional expenditures on information and communication technologies (ICT)*	*Integral indicator of the formation of the digital infrastructure of the region I_1*	*Integral indicator of the implementation of the region's capabilities using digital technologies I_2*	*Integral indicator of the effectiveness of the region's digitalisation policy I_3*	*Overall integral indicator of digital development efficiency I_{edd}*
Karachay-Cherkess Republic	61.3	69	84.7	79.4	26.0	20	61.3	0.825	0.37	599	0.481	0.792	1.055	0.804
North Ossetia Republic	63.3	83.6	83.6	88.8	23.0	24.6	46.5	0.848	0.36	819	0.396	0.821	1.057	0.788
Chechen Republic	72.3	50.2	85.1	69.3	23.0	7.5	54	0.807	0.27	1411	0.556	1.051	1.12	0.93
Stavropol region	61.7	68.6	91.1	85.1	29.0	18.1	66.2	0.847	0.35	5321	0.466	0.766	1.057	0.792
Bashkortostan	70.4	77.9	88.8	84.5	29.0	23	78.1	0.865	0.43	19077	0.343	0.657	1.005	0.702
Mari El Republic	71.8	65.9	81.8	83.4	24.0	21.3	63.9	0.854	0.39	1437	0.438	0.768	1.040	0.778
Mordovia Republic	56.5	65.2	89.6	74.9	22.0	21.9	71.9	0.863	0.32	1346	0.532	0.778	1.080	0.825
Tatarstan	63.5	80.2	97.7	92.8	30.0	36.8	81.4	0.914	0.52	24438	0.381	0.407	0.975	0.626
Udmurtia Republic	72.8	69.1	87	78.6	23.0	27	64	0.878	0.37	4588	0.390	0.711	1.046	0.749
Chuvash Republic	64.3	62.3	91.3	72.7	27.0	30.2	60	0.852	0.38	2911	0.490	0.67	1.046	0.766
Perm region	59	67.4	90	78.2	27.0	25.2	48.4	0.876	0.38	16856	0.497	0.78	1.028	0.794

Table 2 Calculation of integral indicators of the regional digital development, 2018 (continued)

Region	*Percentage of households with a personal computer*	*Percentage of households with broadband internet access*	*Organisations with broadband internet access*	*Users of the internet among households in the region*	*Business digitalisation index in the region*	*Percentage of households in the region shopping online*	*Percentage of households in the region receiving public services online*	*Regional human development index*	*Index of socio-economic conditions of innovation activity in the region*	*Regional expenditures on information and communication technologies (ICT)*	*Integral indicator of the formation of the digital infrastructure of the region I_1*	*Integral indicator of the implementation of the region's capabilities using digital technologies I_2*	*Integral indicator of the effectiveness of the region's digitalisation policy I_3*	*Overall integral indicator of digital development efficiency I_{edd}*
Kirov region	69.3	64	87.9	75.5	23.0	25.7	55.4	0.857	0.31	2969	0.449	0.78	1.086	0.803
N. Novgorod region	62	72.4	93	78.7	30.0	34.8	63.4	0.873	0.4	22679	0.438	0.547	1.015	0.701
Orenburg region	68.7	74.9	94.3	81.7	28.0	24.2	63.8	0.876	0.36	5854	0.365	0.693	1.050	0.738
Penza region	76.9	71.4	84.5	80.2	26.0	24.7	66.3	0.861	0.38	2642	0.355	0.697	1.046	0.734
Samara region	67	79.8	78.4	87.1	23.0	25.5	54.9	0.884	0.49	19634	0.402	0.756	0.985	0.741
Saratov region	81.09	72.4	79.5	81.2	23.0	19.5	65.3	0.865	0.41	18569	0.349	0.802	1.015	0.751
Ulyanovsk region	71.9	70.4	83.5	72.6	23.0	9.8	56	0.858	0.33	5070	0.398	0.995	1.070	0.846
Kurgan region	72.7	64.2	75.4	75.8	21.0	23.6	43.2	0.843	0.40	1609	0.474	0.902	1.035	0.827
Sverdlovsk region	64.3	72.5	88.6	80.3	30.0	30.4	47.2	0.889	0.48	30711	0.426	0.702	0.975	0.728
Tyumen region	83.1	84.1	85.4	89.7	28.0	46.1	74	0.914	0.46	51949	0.226	0.325	0.959	0.549
Khanty-Mansi Autonomous Okrug	86.1	88.9	86.7	92.2	28.0	44.6	71.2	0.911	0.47	27867	0.173	0.353	0.982	0.551
Yamalo-Nenets Autonomous Okrug	96.5	96.3	83.8	97.1	26.0	65	86.1	0.901	0.48	9701	0.142	0.235	0.999	0.513

Table 2 Calculation of integral indicators of the regional digital development, 2018 (continued)

Region	*Percentage of households with a personal computer*	*Percentage of households with broadband internet access*	*Organisations with broadband internet access*	*Users of the internet among households in the region*	*Business digitalisation index in the region*	*Percentage of households in the region shopping online*	*Percentage of households in the region receiving public services online*	*Regional human development index*	*Index of socio-economic conditions of innovation activity in the region*	*Regional expenditures on information and communication technologies (ICT)*	*Integral indicator of the formation of the digital infrastructure of the region I_1*	*Integral indicator of the implementation of the region's capabilities using digital technologies I_2*	*Integral indicator of the effectiveness of the region's digitalisation policy I_3*	*Overall integral indicator of digital development efficiency I_{edd}*
Chelyabinsk region	71.2	74.2	86.6	82.6	28.0	27.3	60.7	0.879	0.47	14022	0.366	0.662	0.997	0.707
Altai Republic	72.5	84.4	86	80.9	24.0	60.1	56.4	0.826	0.36	693	0.302	0.491	1.06	0.662
Buryat Republic	72.6	68.6	68.2	83.9	20.0	26.5	45.4	0.83	0.39	2111	0.485	0.854	1.039	0.817
Tyva Republic	69.2	87.4	74.3	85.2	21.0	22.8	78.8	0.801	0.37	647	0.382	0.753	1.055	0.763
Khakassia Republic	66.3	54.5	82	81.7	25.0	16.9	64	0.86	0.3	1884	0.559	0.823	1.098	0.854
Altai region	57.5	69.4	84.6	79.9	24.0	27	68.3	0.838	0.32	4594	0.509	0.684	1.082	0.791
Zabaikalsky region	65.6	62.3	83.7	76.6	25.0	17.2	37.8	0.836	0.32	3337	0.498	0.972	1.079	0.873
Krasnoyarsk region	69.9	66.8	85.6	82.3	25.0	26.1	80.4	0.892	0.44	16434	0.430	0.642	1.003	0.723
Irkutsk region	61.7	69.9	79.9	79.5	26.0	21.3	54.5	0.877	0.41	16843	0.488	0.798	1.016	0.792
Kemerovo region	70.5	66.4	84	79.5	26.0	21.7	45.7	0.862	0.41	7131	0.434	0.847	1.024	0.794
Novosibirsk region	66.4	74.5	80.3	81.4	23.0	26.2	51.9	0.883	0.39	20476	0.425	0.775	1.019	0.768
Omsk region	65.3	74	86.9	80	24.0	25.2	62.2	0.879	0.45	5806	0.413	0.726	1.01	0.746

Table 2 Calculation of integral indicators of the regional digital development, 2018 (continued)

Region	*Percentage of households with a personal computer*	*Percentage of households with broadband internet access*	*Organisations with broadband internet access*	*Users of the internet among households in the region*	*Business digitalisation index in the region*	*Percentage of households in the region shopping online*	*Percentage of households in the region receiving public services online*	*Regional human development index*	*Index of socio-economic conditions of innovation activity in the region*	*Regional expenditures on information and communication technologies (ICT)*	*Integral indicator of the formation of the digital infrastructure of the region I_1*	*Integral indicator of the implementation of the region's capabilities using digital technologies I_2*	*Integral indicator of the effectiveness of the region's digitalisation policy I_3*	*Overall integral indicator of digital development efficiency I_{edd}*
Tomsk region	70	63.7	80.1	82	23.0	26.1	51.7	0.897	0.52	5616	0.472	0.775	0.996	0.772
Sakha Republic (Yakutia)	67.3	62	73.4	85.8	22.0	31.2	46.2	0.903	0.44	6556	0.529	0.758	1.014	0.792
Kamchatka region	77.5	78.5	85.3	82.3	24.0	43.8	54.3	0.854	0.40	2074	0.298	0.566	1.035	0.673
Primorsky region	60.7	73.9	88.7	83.5	25.0	28.9	64.8	0.854	0.38	9261	0.447	0.649	1.038	0.744
Khabarovsk region	72.3	79.7	89.4	82.1	27.0	28.8	49.5	0.865	0.48	6637	0.316	0.721	1.001	0.711
Amur region	65.4	71.5	79.3	83.4	23.0	18.4	67.1	0.84	0.35	2780	0.453	0.811	1.063	0.804
Magadan region	77.7	75.8	84.1	86.4	23.0	30.6	37.8	0.897	0.38	1705	0.320	0.815	1.047	0.759
Sakhalin region	71.1	71.8	87.1	77.6	27.0	30.9	57.2	0.896	0.39	10589	0.382	0.654	1.034	0.724
Jewish Autonomous region	55.3	65.6	83	77	22.0	24.2	36.4	0.824	0.28	318	0.554	0.93	1.115	0.891
Chukotka Autonomous okrug	83.5	59.1	89.6	91.7	22.0	31.8	19.2	0.867	0.28	740	0.417	0.974	1.112	0.862

In the Moscow region, increased attention is paid to issues of cybersecurity, the creation of unified platforms for cross-border cooperation, the development of marketplaces for businesses, and the work of support and design institutions.

Moscow and the Moscow region also occupy the top positions in the rating of regions for the quality of life – 2020 (RIArating, 2021). The development of infrastructure, the high level of economic and social progress, along with the high potential for further growth, allows these regions to stay in the top of the rating for a long time.

The group of regions that have overcome the digitalisation trap also includes the Tyumen region, the Khanty-Mansi Autonomous okrug, and the Yamalo-Nenets Autonomous okrug.

The Khanty-Mansi Autonomous okrug is also among the top ten regions of the country with a high level of economic development (they generally account for about 40% of the total GRP of the subjects of the Russian Federation, retail trade turnover of the Russian Federation, investment in fixed assets).

According to the results of 2020, the Yamalo-Nenets Autonomous okrug and the Tyumen region are on the 11th and 14th places, respectively, in the rating on the standard of living among Russian regions (MKRU, 2020). Both regions are among the most 'digitised' regions of the country according to the results of the implementation of the national project "Digital Economy". In particular, the Tyumen region is implementing five regional programs aimed at developing infrastructure, security, technology, digital public administration, and training personnel for the digital economy. In 2019, the territories of these regions were actively connected to the internet of socially significant objects (schools, paramedic and midwife stations), even in remote areas, the speed and quality of work with internet resources increased several times.

The authors checked the reliability of the obtained results by calculating:

1 Correlation coefficient (r_1) between the integral indicator of the formation of digital infrastructure ($I_{1)}$ and the integral indicator of the implementation of the region's capabilities using digital technologies (I_2): $r_1 = 0.665$ – the correlation on the Chaddock scale is direct, noticeable, i.e., by 67% the level of digital infrastructure formation determines the implementation of the region's capabilities using digital technologies (Chaddock, 1925).

2 Correlation coefficient (r_2) between the integral indicator of the implementation of the region's capabilities using digital technologies (I_2) and the integral indicator of the effectiveness of digitalisation policy (I_3): $r_2 = 0.442$-the correlation on the Chaddock scale is direct, moderate (Chaddock, 1925);

3 Correlation coefficient (r_3) between the integral indicator of digital infrastructure formation (I_1) and the integral indicator of digitalisation policy effectiveness (I_3): $r_3 = 0.411$– the correlation on the Chaddock scale is direct, moderate (Chaddock, 1925).

According to the authors, the current situation requires improving the quality of state management of digitalisation processes based on the differentiation of state policy in relation to the regions that have overcome the digitalisation trap and the regions that are in the digitalisation trap (Table 3).

Table 3 Measures of the state policy on digitalisation of regions

Implemented measures	*The regions that are in the digitalisation trap*	*The regions that have overcome the digitalisation trap*
Institutional	Development of a regional strategy for accelerated digital development and the formation of a single institutional framework for regulating the digital economy (Sukharev, 2013)	Improving the institutional framework for regulating the digital economy
	Creating an analogue fund as an institutional framework for maintaining a dynamic business environment for enterprises using digital technologies and stimulating their innovation activity	
Infrastructural	Development of digital infrastructure and increasing the availability of the internet for the population, business structures and public authorities (Bukht and Heeks, 2018)	The policy of interregional digital alignment based on redistributive and adaptive mechanisms of regional development (Bauer, 2018; Stiakakis et al., 2010)
	Expanding the range of digital government services	
Scientific and technological	Creating conditions (institutional, economic, tax) for the development of R & D as the basis of high-tech production in the region	Improving the policy in the field of scientific and technological development of the region, creating innovative clusters with the participation of scientific, educational, industrial organisations of the region, as well as regional government bodies
	Involvement of the business sector in R&D financing	Promotion of investment projects in the field of digital development, creation of special economic zones (Antipova and Rodionova, 2016)
	Development and implementation of PPP mechanisms as a form of state support for R & D in the region	
	Implementation of measures to ensure the information security of the region	
Educational	Development of the sphere of fundamental and applied scientific research on the basis of regional educational organisations	Implementation of training and retraining programs for the digital economy.
	Implementation of programs to improve digital literacy of the population (Hargittai, 2002)	

Source: Compiled by the authors

The regions that can quickly overcome the 'digitalisation trap' and integrate into the digital space will receive the greatest digital dividends, while the rest are likely to be among the laggards.

5 Conclusion

The author's hypothesis about the existence of a 'digitalisation trap' of Russian regions, which determines the country's digital lag in the world, is confirmed. The calculation of the integral indicator of the formation of digital infrastructure allowed the authors to conclude that there are significant digital gaps between the regions of Russia. It is confirmed that the existing digital gaps between regions provoke the emergence of a new gap – a gap in the implementation of regional development opportunities using digital technologies. The calculation of an integral indicator of the effectiveness of the digitalisation policy of regions allowed the authors to conclude that its implementation is ineffective in most regions of Russia.

The calculation of the overall integral indicator of the digital development efficiency of the region allowed the authors to rank the regions of Russia into two groups – regions that have overcome the 'digitalisation trap' (5 regions), and regions that are in the 'digitalisation trap' (78 regions of the country).

According to the authors, the current situation requires improving the quality of public management of digitalisation processes based on the differentiation of public policy in relation to regions that have overcome the digitalisation trap and regions that are in the digitalisation trap. Public policies for regions that are in the digitalisation trap should ensure the enhanced digital infrastructure development and be based on the principles of 'leap' (first proposed by Schumpeterian economists together with the concept of 'Windows of opportunity' as a technologically sound strategy for catching up) by creating a stable analogue foundation. The analogue foundation is formed from an institutional framework that supports a dynamic business environment for businesses that use digital technologies in practice to maintain competition; digital literacy of citizens and specialists, contributing to the opportunities for future development of the region and the country; accountable institutions in empowering citizens through the use of the internet (Karpunina et al., 2020).

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Note

[1]Calculations were made for 84 regions of Russian Federation (The Nenets Autonomous okrug, which is part of the Arkhangelsk region, was excluded from the calculations by the authors due to the lack of complete statistical data within the analysed indicators).