VALUATING THE APPROPRIATION OF DIGITAL TECHNOLOGIES ACROSS RUSSIAN REGIONS

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The COVID-19 pandemic has proved a powerful catalyst for the integration of digital technologies in everyday life. Many digital routines have replaced the traditional ones relating to purchasing goods and services, information exchange, movement, document issuance, or scheduling medical appointments. Despite technology proliferating through society, the digital divide is widening. The place of residence is a factor affecting the involvement in digitalisation, along with age, education, income, and the availability of ICT infrastructure. This study evaluates the readiness of the population of various Russian regions to embrace digital technologies. Based on a comparative analysis of traffic to the most popular websites on the Russian Internet, grouped into five categories (e-commerce, e-government, information exchange, spatial mobility, scholarly communication), an index method for assessing readiness for digitalisation is developed. The study uses Yandex search data from February 2019 to January 2021. The findings suggest that Russian regions may be divided into digitally advanced areas, runner-ups, average performers, and the digital periphery. Recommendations are given on how to increase readiness for digital transformation in territories of different types without running the risks of forced digitalisation.

Keywords:
society digitalisation, digital divide, digital routine, internet appropriation, digital inclusion, digital transformation, typology of Russian regions, digitalisation threats, e-commerce, digital footprint, information society

Introduction and problem setting

The digital divide is part of the new socio-economic reality of global space development, and the COVID-19 pandemic spotlighted its negative effects. Pandemic-induced instant changes in everyday life and socialisation made state participation in developing basic information and communication infrastructure and making digital technology available to all a major national security factor. The year 2020 demonstrated that a rapid digital transformation was impossible in emergency conditions when it was impossible to meet basic digitalisation criteria. The population lacked digital skills, and the infrastructure was not widely available. All this caused the fall of economic activity, limited access to government services, and heightened social tensions.

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A summary analysis of earlier findings suggests that the digital divide may be looked at as a new type of social inequality, which arises not so much from poor Internet access but from the capacity of users to embrace the Internet as a tool to improve their lives [1]. The most important aspects of digital inequality are the socio-demographic profile of users, the coverage area, the cost of services, and average speed; variations in the goals and results of using digital technology. It has been shown [2] that motivational, cognitive, and economic barriers to utilising digital resources are more formidable than infrastructural ones. Rural residents, workers with basic vocational education, and poor and vulnerable families confirm this pattern. Young people, city residents, entrepreneurs, and professionals with a higher education stand out for their positive motivation and considerable digital activity and literacy, which influence effective adaptive practices. The growing popularity of self-employment and freelance work is creating a new digital generation, for which Internet access from any part of the world is an absolute necessity [3]. Digital integration, a new social lift in an information society, is emerging as a counterweight to digital isolation [1].

Of particular interest is exploring the spatial patterns of the digital divide. For instance, it has been demonstrated [4] that the way a person embraces the 'urban digital lifestyle' is affected by both their socio-economic standing and the place of residence. Having studied the digital practices of people living in four districts of Tel Aviv, the authors concluded that location remains the key socio-spatial determinant of human life in the digital era. A similar study conducted in Nánjīng, the capital of Jiangsu province in East China [5], shows that the online activity of different socio-economic groups varies despite similar ICT opportunities. The most significant influences on the model of digital technology usage were the socio-economic standing and the characteristics of the location and place of residence.

The connection between ICT development and urbanisation has been demonstrated for Chinese cities in [6]. A time-series analysis of data for district administrative centres proved a positive effect of digital technology on urbanisation. However, the digital divide between the cities is considerable. The technological inferiority of less developed cities and towns is aggravated by the poor digital skills of the population. Another study [7] confirms these findings. Megalopolises and major administrative centres have a high digital development index, whilst cities located in less advantaged central and western regions and the rural south-west of the country score lower. China, the largest ICT market for mobile devices and Internet users, has a sharp digital divide between regions and cities. The situation is similar in Australia, where, despite growing digitalisation, digital integration shows distinct geographical, social, and socio-economic patterns [8].

The problem of digital space inhomogeneity becomes particularly acute when the contrast is drawn between urban and rural areas. An investigation of Scottish villages [9] has shown that the population and small enterprises are not particularly receptive to digital technology. The authors of the study propose the expansion of the coverage area and the involvement of local communities and public and private actors in popularising digital solutions and adapting them to the local context. This problem also arose in the U.S., where the prosperity

of agricultural states, such as South Carolina [10], is becoming increasingly dependent on ICT accessibility. The findings of the study, which agree with those of other investigations, suggest that seniors and low-income and rural households in all demographic groups have limited broadband access.

All EU countries have gross digitalisation disproportions [11]. The imbalance is stable and pronounced in Sweden, Denmark, and the U.K. There are marked differences in the intensity of Internet usage by households and businesses in Finland, Germany, Spain, and some regions of France. It has been demonstrated that a state policy on ICT proliferation has to consider synergistic relationships and the regional context of digitalisation. The connection between regional policies and the narrowing of the digital divide have been explored in Lithuanian regions [12]. The most digitally developed territories are major cities — Vilnius, Klaipeda, and Kaunas, and the least developed area is the Tauragė County bordering Russia. Covid-19 socialisation restrictions emphasised the need for data on EU territories cut off from the Internet. A study carried out in Poland, using GIS technology [13], identifies regions likely to underperform in digital integration. Terrain raster data and vector data on population density, building types, and communication stations show that 10 per cent of the Poles have no access to the Internet.

Spatial aspects of digitalisation have been studied in Russian regions as well. A series of works explores the digital divide between federal districts [14; 15]. It has been shown that significant factors in socio-economic development disparities, including unequal income distribution, are urbanisation, the quality of ICT infrastructure, and good ICT skills. A study of uneven development of digital economy in Russian regions [16] distinguishes 15 leaders in terms of ICT accessibility for the population (including Tatarstan, the Kaliningrad and Tyumen regions, Moscow, and St Petersburg). Among the underperformers are the Republics of Ingushetia and Chechnya, which have poor ICT infrastructure.

Another study [17] presents the results of a spatial-temporal analysis of the development of the Internet in Russia. Most of the country's sparsely populated territory has only satellite Internet access, whilst most national users live in Moscow, St Petersburg, and cities with a population of one million or more. There is a sharp difference between regions and their administrative centres in user activity. An evaluation of secondary digitalisation in more than 90 Russian cities, carried out by the Skolkovo Institute for Emerging Market Studies based on 2019 data, shows that the need for digital services is a more significant factor in the digital divide between cities than the availability of the services [18]. Uneven digitalisation of cities and towns is accompanied in Russia by the digital discrimination of rural areas [19]. All this calls for measures to smooth the transition to an information society [20].

Earlier research into the situation at the level of federal districts and regions highlights stark differences in the availability of ICT infrastructure. It emphasises the dependence of Internet usage on socio-economic factors. However, several questions remain about the openness of people living in different regions to the expansion of digital technology into everyday life. This study aims to measure the digital divide between Russian city residents as digital routines establish themselves.

Methods

The digital receptiveness of regional residents is their ability to pick up ICT skills and apply them in everyday life in performing routine operations. Spatial analysis of the invisible digital footprint or digital shadow of a search query was carried out to evaluate the openness of a region to digital routines. At the first stage of the study, a list of websites frequently visited by the Russians was drawn up. These websites were divided into five categories covering some essential areas of life (table 1).

Table 1

Methodology for creating a database to evaluate digital receptiveness

Query category	Digital routine	Website sample	Query*
E-commerce	Purchasing goods and services online	Wildberries online retailer (www.wildberries.ru), Ozon online retailer (www.ozon.ru), Aliexpress.ru online retailer (www.aliexpress.ru)	Wildberries (8.5m), Ozon (8.4m), Aliexpress (6.8m)
E-government	Getting government services	Gosuslugi public and municipal services portal (www.gosuslugi.ru), the official website of the Federal Tax Service (www.nalog.ru), Moi dokumenty information portal for public and municipal services (моидокументы.рф)	Gosuslugi (15.9m), Federe al Tax Service (1.2m), Moi dokumenty (4.6m)
Obtaining information	Keeping up-to-date wit h the situation in Russia and the world	RIA Nvovsti (ria.ru) and RBC (www.rbc.ru) news portals, Mail.ru news aggregator (news.mail.ru)	RIA (0.5m), RBC (0.7m), Mail.ru news (0.1m)
Spatial mobility	Travel planning	the online accommodation reservation service (www.booking.com), Yandex Maps web mapping platform (yandex.ru/maps), Avisales flight search engine (aviasales.ru)	booking.com (1.2m), Yandex Maps (2.1m), aviasales.ru (0.6m)
Scholarly communication	Dissemination of academic research	CyberLeninka open-access scientific electronic library (cyberleninka.ru), Russian Academy of Sciences (www.ras.ru), Scientific Russia information portal (scientificrussia.ru)	CyberLeninka (0.1m), RAN (1.4m), Scientific Russia (0.06m)

Comment: * most searched queries in Russian in February 2021 according to Yandex Wordstat (the keyword tool). For translation, see the Website sample column.

The website sample was composed using the following criteria: considerable audience coverage across Russia, high traffic on the website, significance to one of the five digital routines, and the availability of quantitative data on user activity. Priority was given to websites from the list of websites of public importance approved in 2020 by the Ministry of Digital Development, Communications, and Mass Media.

Wordstat, the free analytics tool by Yandex, was used at the second stage of the study to create a search query database for 85 Russian regions from February 2019 to January 2021. Yandex provides monthly statistics on search queries. As a research tool, Yandex Wordstat is a better alternative to Google Trends because it allows the user to download absolute location-specific data and not only relative numbers.

An essential methodological element of the study was the semantic analysis of queries to determine popular search forms for each website. Word clouds in figure 1 show the most common tags for the e-commerce category.

Fig. 1. Tag clouds for the website sample in the e-commerce category

Source: Prepared by the author using the wordart.com service.

Although search queries often contain from two to six tags, the most popular queries are shorter. For example, 'озон [ozon] ' accounted for 8.4 m queries; 'магазин озон [ozon store] ' or 'интернет озон [ozon online] ', 2.5 m; 'озон интернет магазин [ozon online store] ', 264,000; 'озон интернет магазин официальный каталог товаров [ozon online store official product catalogue] ', 80,800.

At the third stage, the final index of digital receptiveness of Russian regions was calculated as follows:

- the ratio between monthly views and the annual population size was computed for each of the 15 sample websites;
- the website with the maximum number of regional queries was identified for each month in each category;
- the arithmetic mean of the query view values was calculated for each of the five categories: for 2019, using February-December data; for 2020, January-December data; for 2021, January data;
- the maximum of the mean 2019, 2020, and 2021 values was identified for each region and category;

- the obtained values were normalised using the rank method; the region with the best query to population ratio was ranked first, and that with the worst ratio 85th (ranking was performed for all five categories);
- the final index was calculated as the arithmetic mean of ranks for five categories; its value varies from 1 to 85;
- a typology of Russian regions was produced based on the obtained digital receptiveness index.

Results

Transiting to digital consumption is a sine qua non of e-government, along with digital infrastructure improvement, retail transformation, online payment systems, and better transport and logistics services. The proportion of Russians purchasing goods and services online is growing every year. This increase is confirmed by search query statistics of the major marketplaces, whose websites were chosen for analysis. The Google Trends analytics tool shows that user interest in the Wildberries and Ozon stores almost doubled in 2019—2020. My analysis of fluctuations in monthly search queries for e-commerce websites across Russian regions from February 2019 to January 2021 showed seasonal changes in demand, with the most rapid growth in the last months of the year — October, November, and December. However, April 2020 witnessed an unusual surge in demand for e-commerce, which was explained by many Russians observing the lockdown rules. Figure 2 demonstrates the digital gap between Russian regions based on aggregate 2019—2021 data.

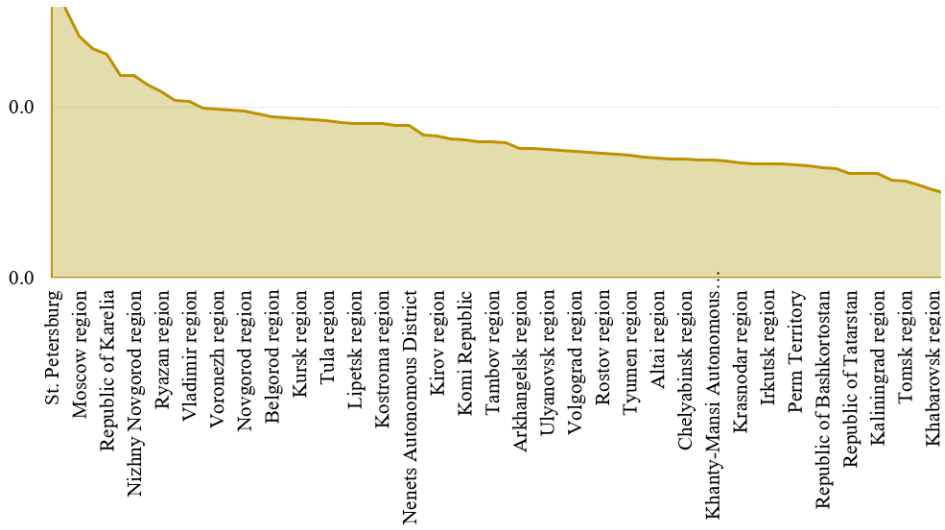

Fig. 2. Distribution of Russian regions by maximum average annual views of e-commerce websites per capita

Source: prepared by the author.

Comment: the graph covers 85 Russian regions, but only selected ones are titled.

Online consumption is most popular in Moscow and St Petersburg and the neighbouring near-capital Moscow, Tver, Nizhny Novgorod, Leningrad, Ryazan, Yaroslavl, and Vladimir regions, and the Republic of Karelia. Sevastopol and the Republic of Crimea also scored well. The least open to a digital economy are regions in the North Caucasus Federal district (the Republics of Karachay-Cherkessia, Kabardino-Balkaria, Dagestan, Ingushetia, Chechnya, North Ossetia-Alania), Far Eastern federal district (the Republic of Sakha, the Jewish autonomous region, the Perm and Amur regions), and the Siberian federal district (the Republic of Tyva). There is a vast, 31.6-fold, difference between the leaders and the underperformers.

Important factors in this spatial distribution are transport costs and time of delivery. Since most online orders are shipped from Moscow, delivery to distant regions takes more time and costs more. Another factor behind the territorial digital gap is regional inequalities in socio-economic development. The correlation coefficient between e-commerce website views per capita and the difference between the average monthly nominal salary across all organisations in a region and Moscow in 2019—2020 is negative (–0.13). In other words, the lower the income, the more reluctant a person is to shop online.

Another category of digital routines is reading Russian and international news online. ICT development created the conditions for rapid information dissemination. News websites are updated several times an hour, and the user has to refresh the page constantly to stay abreast of things. Voluntary or involuntary isolation from the information field results in digital marginalisation. Figure 3 demonstrates the geography of traffic to news websites.

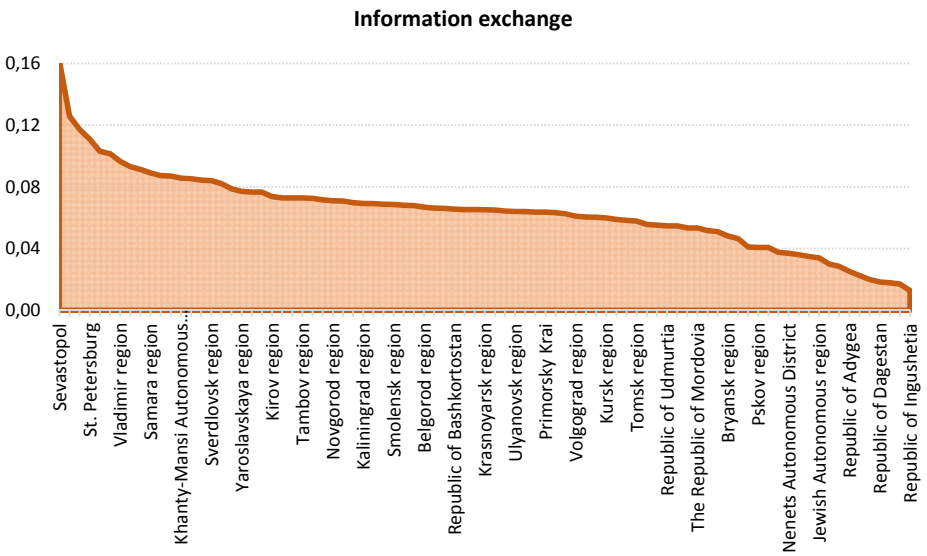

Fig. 3. The distribution of Russian regions by maximum average annual views of news websites per capita

Source: prepared by the author.

Comment: the graph covers 85 Russian regions, but only selected ones are titled.

Regions most involved in the national information space are Russia's two capitals — Moscow and Sant Petersburg; the newly acquired territories keenly interested in recent developments in the country (the Republic of Crimea and Sevastopol); major centres of research and industrial production (the Nizhny Novgorod and Novosibirsk regions). Digital peripheries in terms of news consumption are the Chukotka, Nenets, and Jewish autonomous regions and territories of the North Caucasus federal district. The digital gap between the regions ranked 1st and 85th was 12.8-fold. I calculated bivariate correlation coefficients for the maximum average annual views of news websites per capita, the proportion of the urban population (0.53), and the number of broadband users per 100 people in 2019. The coefficients demonstrate that urbanisation is a more significant factor in digitalisation than infrastructure. Regions with a greater proportion of the urban population were more actively involved in the virtual information environment.

The most developed of the five digital routine categories are digital relations between the government and the population (fig. 4). The virtualisation of document issuance is essential to the digital transformation of the state. Initiatives such as the national public service portal or taxpayer's home page increase the efficiency and transparency of interaction between the state and the citizen.

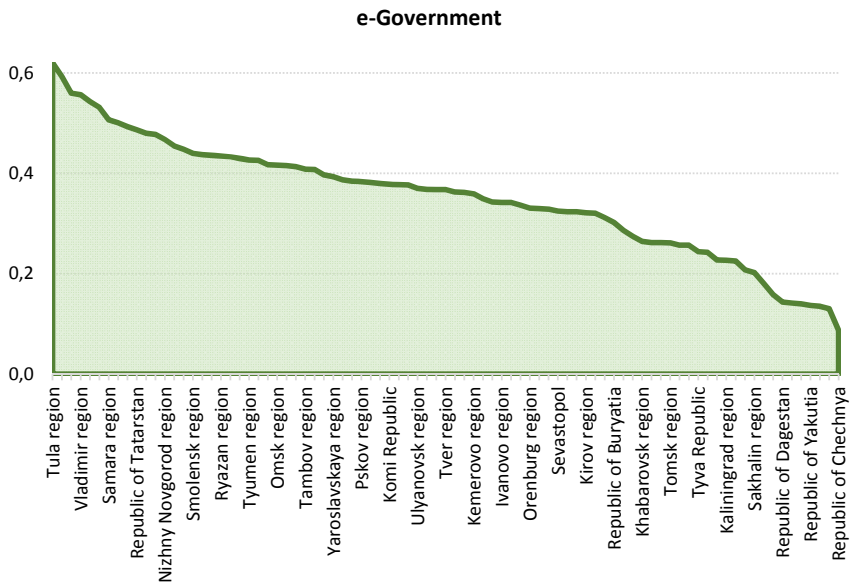

Fig. 4. The distribution of Russian regions by views of e-government websites per capita

Source: prepared by the author.

Comment: the graph covers 85 Russian regions, but only selected ones are titled.

Territories most open to e-government services are Moscow, the Republic of Tatarstan, and the Moscow, Tula, Vladimir, Sverdlovsk, Oryol, Samara, Novosibirsk, and Kostroma regions. They considerably outperform North Caucasus and Far Eastern regions. The difference between the leader and the outsider in this respect is sevenfold. An evaluation of the influence of urban population concentration and Internet usage by organisations, performed by computing correlations, suggests that both factors are equally significant for promoting e-government.

The other two categories, spatial mobility (fig. 5) and scholarly communication (fig. 6), are less popular among the population of Russia. The gap in openness to digitalisation in research is 27.9-fold; in travel, 34.3-fold.

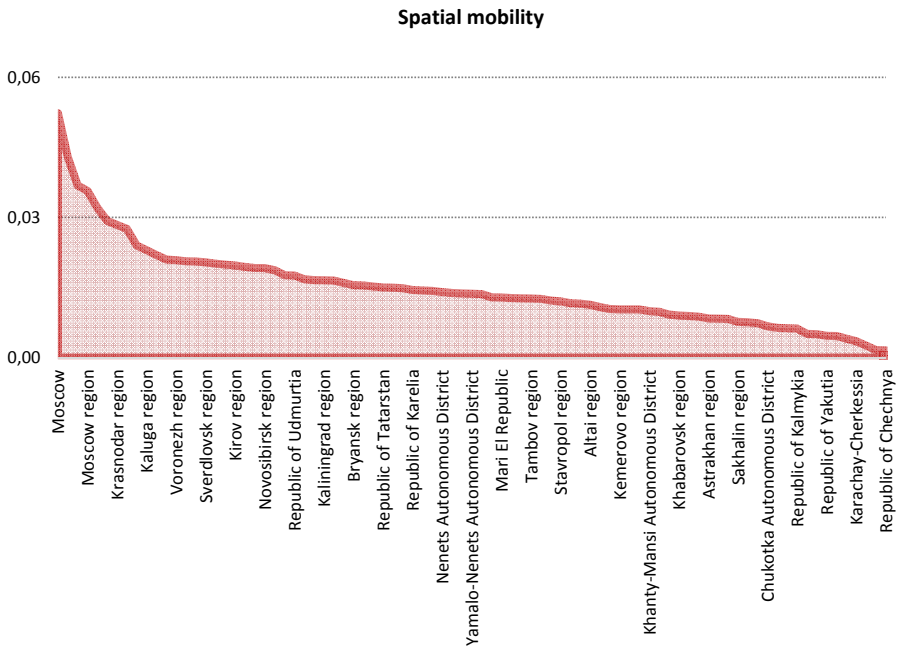

Fig. 5. The distribution of Russian regions by maximum average annual views of websites focusing on spatial mobility, per capita

Source: prepared by the author.

Comment: the graph covers 85 Russian regions, but only selected ones are titled.

Leaders in the use of digital services in travel planning are popular tourist destinations — Moscow, St Petersburg, Sevastopol, the Republic of Crimea, and the Moscow, Nizhny Novgorod, Krasnodar, Yaroslavl, and Vladimir regions. As to scholarly communication, the Novosibirsk region ranks first.

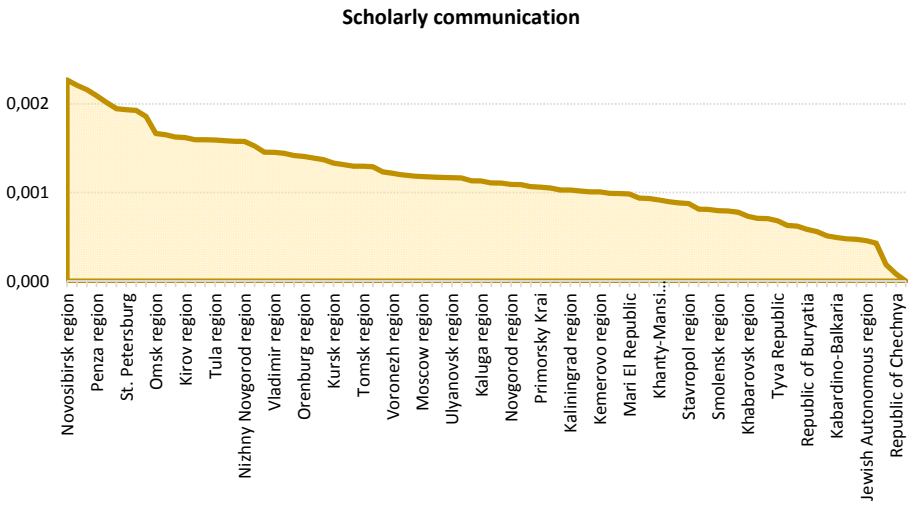

Fig. 6. The distribution of Russian regions by the maximum average annual views of scholarly communication websites per capita

Source: prepared by the author.

Comment: the graph covers 85 Russian regions, but only selected ones are titled.

Discussion

Figure 7 shows a typology of Russian regions according to the openness of their populations to digitalisation. The typology is based on a comprehensive evaluation of the five categories of digital routines. Regions are divided into advanced areas, runner-ups, average performers, and the digital periphery.

The advanced areas are 16 regions with the best final digital receptiveness index. They are located in six federal districts: Central (Moscow and the Vladimir, Moscow, Ryazan, Yaroslavl, Tula, Voronezh, Kaluga, and Oryol regions); North-Western (St Petersburg); Volga (the Nizhny Novgorod and Samara regions); Southern (the Republic of Crimea and Sevastopol). These regions are leaders in the use of digital technology by the population in everyday life (fig. 8). They are highly receptive to digital technology across most of the studied categories, particularly spatial mobility, information exchange, and e-governance. In regions with a robust research environment (Moscow, St Petersburg, the Novosibirsk region, and others), scholarly communication rapidly develops.

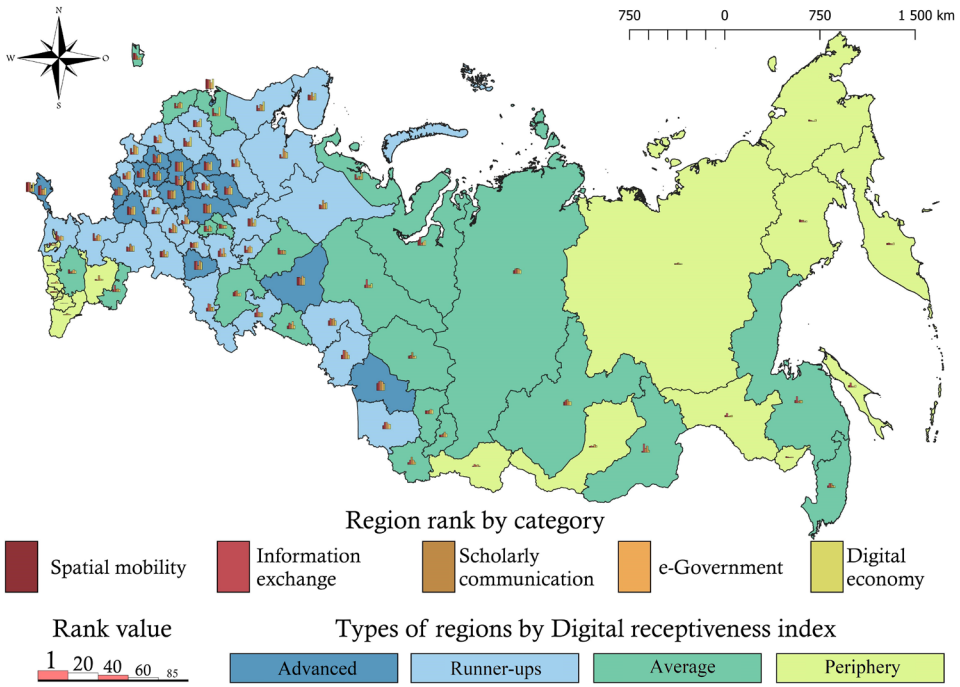

Fig. 7. A typology of Russian regions according to digitalisation receptiveness

Source: prepared by the author.

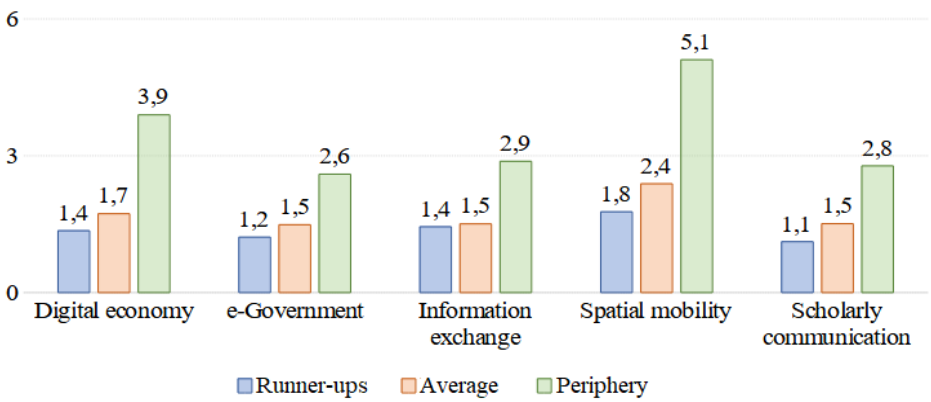

Fig. 8. The digital gap between the advanced areas and all other regions, times

Source: calculated by the author.

Runner-ups are 30 Russian regions, most of them located in three federal districts: 30 per cent in the Central federal district; 26.7 per cent, the Volga; 20 per cent, North-Western.

Among these territories, the Kostroma region performs the best and the Orenburg region the worst. Runner-ups are open to digital technology, outstripped

only by advanced areas (fig. 8). As a rule, digital receptiveness is the highest in three or four of the studied categories, with the dominance of one. This prevailing category is spatial mobility in the Krasnodar region, information exchange in the Omsk and Chelyabinsk regions, e-government in the Kostroma and Bryansk region, digital economy in the Tver region and the Republic of Karelia.

The average performers are 22 Russian regions. Seven are in the Volga federal district; six are in the Siberian; four are in the North-Western; three are in the Ural; one is in the Southern; one is in the North Caucasus. The population of these territories is receptive to digitalisation. However, it lags behind advanced areas and runner-ups in the digitalisation of spatial mobility and scholarly communication, whilst the gap in information exchange is the narrowest (fig. 8).

The digital periphery comprises 17 Russian regions, most of which are in the Far Eastern (47 per cent) and North Caucasus (35 per cent) federal districts. The indices of digital receptiveness range from 67.8 in the Sakhalin region to 84.8 in the Republic of Chechnya. Residents of peripheries are disinclined to use digital technology in everyday life. These regions perform much worse than others in Russia (fig. 8). Moreover, they do not have a leading category of digital services that could increase the digital receptiveness of the population (fig. 9).

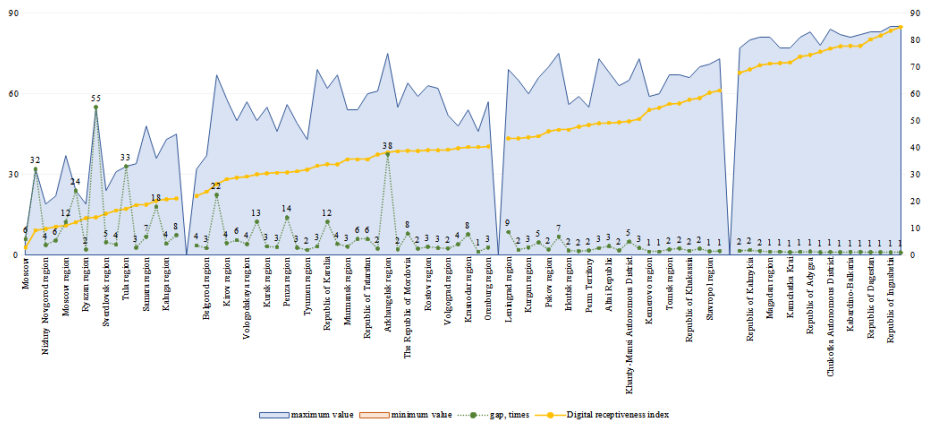

Fig. 9. The gap between the maximum and minimum rank values across Russian regions, by digital receptiveness categories

Source: prepared by the author.

Comment: Russian regions are grouped into four types (from left to right): advanced areas, runner-ups, average performers, digital peripheries.

The geography of regions makes it possible to identify digital belts running radially from Moscow. The coefficient of correlation between the final index value and the distance from the centre of a region to Moscow (0.6) confirms a significant dependence between these two factors.

The results obtained for the digital receptiveness of residents of Russian regions were analysed more thoroughly by comparing them with data on Digital Dictation — a nationwide annual educational event aimed to measure digital literacy among different groups of population.[1] In 2020, over 330,000 people aged 7 to 60 and older took part in the digital literacy survey. The average level of digital literacy across all regions was 7.25 points out of 10. In 33 regions, the values were above the national average. Data are lacking for six regions of the Southern federal district (Sevastopol, the Rostov, Astrakhan, and Krasnodar regions, and the Republics of Crimea and Kalmykia), where few residents participated in the event. The digital consumption category, which represents skills in using digital resources, software, and applications as part of digital literacy, is associated with the lowest values (6.86) in Russian regions compared to the two other categories — digital competencies (7.41) and digital security (7.47). These results indicate that the Russians lack the practical knowledge and skills needed for the further digitalisation of routines.

Figure 10 shows the dependence between digital receptiveness and digital literacy.

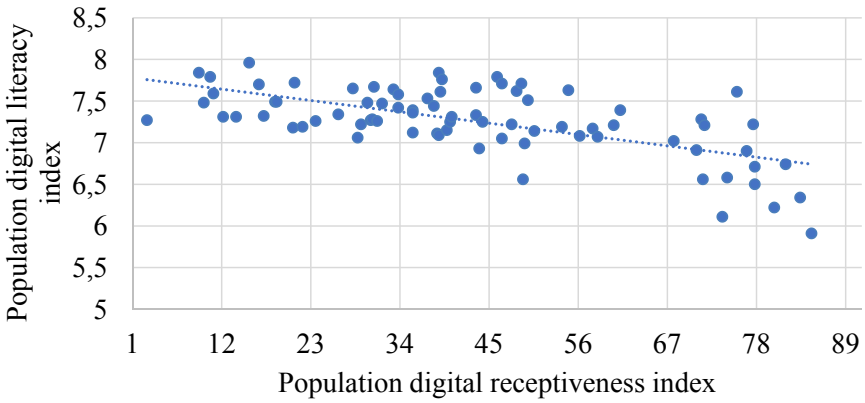

Fig. 10. The distribution of Russian regions by digital receptiveness and digital literacy, 2020

Comment: the intervals of digital literacy values (from 1 to 10, where 10 is the best result) and digital receptiveness (from 1 to 85, where 1 means the best performance).

Source: prepared by the author based on data from [21].

The correlation between these indicators (0.64) points to the importance of the educational factor in embracing digital technology as part of everyday routines. The average digital literacy values for the four types of regions (7.53 in advanced areas, 7.38 in runner-ups, 7.29 in average performers, and 6.74 in

[1] The Digital Dictation 2020 nationwide event, 2021, *Digital Dictation 2020,* available at: https://digitaldictation.ru/site/2020 (accessed 19.06.2021).

the digital periphery) reveal a positive correlation between user awareness of safe and effective ways to benefit from digital technology and the pace at which users embrace digital routines. An analysis of the bivariate correlation coefficient between the digital literacy index and the digital responsiveness subindex showed a stronger association with the categories of digital economy (0.64) and spatial mobility (0.59). Information exchange (0.49), scholarly communication (0.47), public services online (0.48) are less dependent on individual digital competencies.

Conclusions

This study has shown that the examination of digital receptiveness to the integration of ICT in everyday life is an object of not only social science, economics, or psychology but also human geography. The investigation of digitalisation revealed interesting spatial patterns. Firstly, the national digital space has a centre-periphery structure with the radial weakening of demand for digital routines from Moscow towards remote regions. Secondly, there is pronounced interregional and inter-sectoral disparity in the receptiveness of the population of Russian regions to selected categories of digital routines. Online public services have gained the most popularity, narrowing the gap between the advanced areas and the digital periphery. The difference is the sharpest in the use of spatial mobility services. Popular tourist destinations are absolute leaders in this respect. Thirdly, socio-economic factors affect not only ICT availability, as previous research suggests (see [14; 15]), but also the acceptance of digital routines. The best performers, particularly in e-commerce, are Russian regions with higher incomes and a more substantial proportion of the urban population. The infrastructural factor proved to be less important. Fourthly, there is a positive but not exhaustive correlation between digital literacy and digital receptiveness. The more aware the population is of digital technology, the more complex digital routines are establishing themselves. This principle chiefly applies to digital economy and spatial mobility.

There is a considerable interregional disparity in Russia in the degree of digitalisation. Regions in the country fall into four categories: advanced territories, runner-ups, average performers, and the digital periphery. Accelerated digitalisation will have different consequences for regions of each type. Whilst residents of advanced areas will rapidly adapt to digital routines, the population of the digital periphery is likely to resist and resent the change. Therefore, a national policy towards e-governance and an information society should accompany socio-economic measures rather than precede them. The findings of this and previous studies into secondary digitalisation suggest that growing living standards are a sine qua non of reducing digital inequality. Special attention should be paid to raising living standards in Russian regions, particularly average performers and the digital periphery. Digitalisation will positively affect a region and the digital transformation of its socio-economic system only if there are

basic prerequisites for these processes, such as a favourable socio-economic environment, developed ICT infrastructure, and a stable Internet connection. Another important factor is the improvement of digital literacy. Experience, knowledge, and skills in using different digital services advance the integration of more complex digital technology in social processes. Growth in the digital literacy of the population in the digital periphery may be facilitated naturally by a wider rollout of e-government services, which are currently the most popular online routine.

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