ORIGINAL PAPER

DOI: 10.26794/2587-5671-2020-24-5-72-83
UDC 330.332.012(045)
JEL R11, C23, C43, C82, O11, O52

The Impact of Digital Transformation on the Investment Potential of the Russian Cities

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ABSTRACT

The digital transformation of all socio-economic spheres of the country determines the inclusion of digital factors in the assessment of investment potential. The **aim** of this paper is to justify the need to include digital factors in assessing the investment potential and the assessment of the digital potential of St. Petersburg. The study includes statistical **methods** of correlation analysis, average values, comparison, and grouping. This paper defines the concept of digital potential; highlights indicators of digital technology development; presents a methodology and assessment of the digital capacity of St. Petersburg compared with other cities of federal status through 2016–2018. The author features three key components of digital potential: information and communication technology (ICT) infrastructure, digital government, and e-business. The study shows that St. Petersburg's digital potential is sustainably growing. The research reveals that the digital capacity of St. Petersburg is improving by boosting the "e-business" component which reflects the use of ERP and CRM systems by organizations, as well as by the e-commerce. The low level of the "digital government" component has a negative effect on the integral level of digital potential despite the ongoing digitization process in the public sector services. The **conclusions** of the study suggest that the use of digital channels to interact with public authorities, the digitization of businesses, as well as the implementation of electronic workflow processes will improve the digital potential of St. Petersburg. Taking digital factors into account as a part of the investment potential of a city will make it possible to accurately assess its investment attractiveness. The **findings** of the study may be useful to scientists, rating agencies, and government officials when making investment decisions. The **prospects** for future research on this topic consist of expanding its base, clarifying the components of the digital potential factors, and methods for assessing the investment attractiveness of a territorial entity.

Keywords: digital potential; investment potential; information and communication technology (ICT); digital economy; digital transformation; investment attractiveness

For citation: **Kiseleva E.G. The impact of digital transformation on the investment potential of the Russian cities.** ***Finance: Theory and Practice.*** **2020;24(5):72-83. (In Russ.). DOI: 10.26794/2587-5671-2020-24-5-72-83**

INTRODUCTION

The growth of digital technologies has a significant impact on the investment potential of a city and its investment attractiveness. The society engagement in the digital economy in Russia ranks seventh among other countries.[1] Russia cities and regions of Russia, where technological and innovative projects are being implemented, have more opportunities for increasing economic and investment activity, as well as for attracting business. At the same time, investments play an important role in the introduction and development of digital technologies, and their implementation at different stages of the investment process is the key to the country's economic growth.

The Russian Digital Economy program is being implemented within the framework of the state policy to create the necessary conditions for the development of information and communication technologies (ICT). The program is aimed at creating an ecosystem of digital economy in Russia, where digital data is a key factor in all spheres of socio-economic activity for effective interaction between business, the scientific and educational community, the state, and the citizens.[2] According to the roadmap of the program, state measures are designed until 2024. Thus, the constituent entities of Russia, which have been actively implementing the Digital Economy program since 2017, are involved in digital transformation processes, which, in turn, affect investment attractiveness, forming a new component. The impact of the digital economy on the investment attractiveness of Russian cities has significantly increased over the past five years, which makes it relevant and necessary to develop a methodology for assessing digital capacity, including digital factors of investment capacity for an integrated investment attractiveness assessment.

ANALYSIS OF APPROACHES TO ASSESSMENT

There are several studies devoted to the methodology and assessment of the investment attractiveness of a territorial entity (city, region, country), its relationship with investment capacity and investment risk, the impact on the investment activity of domestic and foreign investors[3] [1–3]. Russian and foreign academic communities, international organizations, credit rating agencies are engaged in the assessment of investment attractiveness. Most scientists agree that investment attractiveness should be considered as a set of objective development factors that affect the investment decision-making process and, therefore, determine the level of capital inflow: "Investment attractiveness is a system of various factors that form the intensity of attracting fixed assets investment" [4]. In most studies of the investment attractiveness of Russian regions, these factors are divided into two types: factors of investment potential and investment risk. At the same time, the investment potential in its content is interpreted as the ability of a subject to satisfy the need for investment resources without attracting borrowed funds, considering the available factors of production [5–7]. A distinctive feature of the investment potential is a consequence of the economic growth of the subject: "the investment capacity is the totality of all the resources of the subject, which provide steady growth of the main economic indicators as a result of their use" [8].

The practical significance of assessing investment attractiveness is ensured by ranking the investment climate characteristics within

[1] Based on the materials of the international industrial forum Innoprom. Industry 4.0. The new stage of the industrial revolution in Russia. URL: https://bfmspb.ru/novosti/industriya-4.0-novyij-etap-razvitiya-promyishlennoj-revolyuczii-v-rossii (accessed on 10.07.2020).

[2] Russian Digital Economy state program. Approved by Government decree No 1632-p of July 28, 2017. URL: http://static.government.ru/media/files/9gFM4FHj4PsB 79I5v7yLVuPgu4bvR 7M0.pdf (accessed on 14.07.2020).

[3] Investment climate of Russian regions: assessment experience and ways of improvement. Moscow: Institute of Economics RAS; 1997. 351 p.

the country (by regions of Russia) or within other countries. In most cases, the investment climate characteristic of the region implies the assessment of investment attractiveness, with the investment capacity being one of its components.

According to the methodology of the well-known credit rating agency Expert RA "the investment capacity is a quantitative characteristic that takes into account how saturated the region is with production factors (natural resources, labor, fixed assets, infrastructure), consumer demand and other indicators affecting the investment potential of the region".[4]

In the popular methodology of the Council of Productive Forces, the regional investment capacity is referred to as "a set of objective economic, social, natural-geographical and other properties of the region that are significant for attracting investment" [9].

Foreign approaches to assessing investment attractiveness are similar to domestic ones. In the World Bank's Investment Climate World Development Report, investment capacity is considered as a set of local factors that determine the ability and incentives of companies to invest in production, create jobs and expand activity.[5]

The methodology for assessing regional investment risks, developed by the Institute for Advanced Studies, IAS in 1995 on request of the Bank of Austria, defines investment capacity as a quantitative characteristic that depends on various factors: economic, social and cultural, innovative, legislative, infrastructural, institutional, environmental [10].

In the Global Foreign Direct Investment Country Attractiveness Index, the investment potential is assessed by identifying proxy indicators that determine a country for investment: macroeconomic and political stability, financial structure, business environment[6] [11]. At the same time, in foreign and Russian studies devoted to the assessment of investment attractiveness, it is often noted that a favorable combination of indicators of investment potential created conditions for increasing investment activity in the region, and, hence, improving the living standards of the population and economic growth. Thus, we are confident that the investment potential is a combination of various factors of regional development that affect the investment processes of a territorial entity.

Factors of investment capacity are usually classified according to the areas of their occurrence: financial, economic, production, labor, consumer, infrastructural, institutional, innovation, natural resources, tourism. At the same time, the composition of indicators characterizing the factors of investment capacity may vary. For example, in the monograph by V.V. Litvinova labor potential is assessed by three indicators [12]. E.G. Chachina described five particular indicators in her dissertation [3]. In the work of another group of researchers, there is no single indicator characterizing the labor factors of investment potential [9]. It is important to note that most of the methods were developed at the end of the twentieth century, therefore, it is necessary to update the composition of indicators in assessing the investment capacity. In particular, the development of digital technologies in the field of the industrial Internet, digital design, high technologies, public services, etc. leads to the digital transformation that affects all sectors of the economy and the process of attracting investment. Hence, digital factors need to be added to investment potential.

[4] The methodology for compiling the rating of investment attractiveness of Russian regions by "RAEKS-Analytics". 2017. URL: https://raex-a.ru/update_files/3_13_method_region.pdf (accessed on 13.08.2020).

[5] World development report 2005: A better investment climate for everyone. Washington, DC: The World Bank; 2005. 290 p. URL: http://documents1.worldbank.org/curated/en/554071468182337250/pdf/288290WDR 00PUB 0r0investment-0climate.pdf (accessed on 13.07.2020).

[6] According to DHAMAN methodology. Source: Methodology of the Arab Investment and Export Guarantee Corporation (DHAMAN). URL: http://www.fdiattractiveness.com/index-methodology/ (accessed on 12.07.2020).

DIGITAL POTENTIAL AS A FACTOR OF INVESTMENT ACTIVITY

A study of the impact of digitalization on investment activity, taking into account global economic processes, conducted by A. Yu. Fadeeva shows a close relationship between the level of development of information and communication technologies of countries — ranked high in digitalization and business environment (Doing Business report), investment potential (Rating of countries with the greatest investment potential BERI), as well as investment attractiveness (Foreign Direct Investment Confidence Index) [13]. A high level of ICT development is a key driver in increasing investment, which has a positive effect on the country's GDP, optimizes government spending, and reduces unemployment. A 1% increase in digital transformation investment leads to a 0.5% growth in GDP and 1.9% in international trade, according to research by consulting agency Accenture.[7] The study also notes that the transfer of public services to a digital platform reduces the cost of public administration by 25–45%. In addition, research materials by foreign scientists indicate that today the impact of ICT on the macroeconomic indicators of countries is not fully taken into account. Thus, according to the latest study by a group of US scientists led by Kevin Fox, the cost of digital social media platforms (Facebook, Twitter, Pinterest, etc.) is equivalent to 0.11% of US GDP, and if the platform's activity had been considered in 2003–2017, the average annual growth rate of the country's GDP would have increased from 1.83 to 1.91% [14].

As for studies devoted to assessing the digital potential of a territorial entity (city, region, country), they are currently none. There are statistical data characterizing the processes of social and business digitalization, as well as studies by Russian scientists devoted to the analysis of trends in various sectors of the Russian economy, indicating the processes of digitalization [15, 16]. The issues of the global impact of the digitalization process on the activities of transnational and technological corporations are considered. It has been proved that digital assets of IT companies should be considered as a separate economic unit that determines the company's capitalization, regardless of the provisions of international investment law, the essential prerequisites for changing which are determined by the scale of the ongoing changes in the technological sphere of developed economies [17].

Recently, the studies have been published on the analysis and assessment of the digital potential of Russian companies, which reflect the view of Russian scientists on the digital potential of an enterprise. In the work of N.V. Gorodnova, D.L. Skipin, A.A. Peshkova [18], it is considered as a unity of three components:

1) resources;
2) internal capacity of the company to implement certain stages of the IT development;
3) functional areas of activity where information technology can be applied.

In the study by A.V. Kozlova, A.B. Teslya [19] the digital potential of an industrial enterprise is defined as an integral indicator reflecting the current level and future opportunities of using digital technologies by an enterprise, factoring in environmental conditions.

Considering the aforementioned, in the next section of the paper the concept of digital capacity is defined; indicators characterizing the development of digital technologies are identified; a methodology was developed and an assessment of the digital capacity of St. Petersburg was carried out in comparison with other cities of federal significance for the period 2016–2018.

[7] Digital technologies at the heart of public service transformation and as a catalyst for economic growth and innovation. Accenture. Report. 2017. URL: https://www.accenture.com/t20150523T033713__w__/us-en/_acnmedia/Accenture/Conversion-Assets/DotCom/Documents/Global/PDF/Dualpub_9/Accenture-Digital-at-Depthfor-Government-Innovation.pdf (accessed on 13.07.2020).

METHODOLOGY AND RESULTS OF DIGITAL CAPACITY ASSESSMENT

Digital capacity is a collection of information and communication technologies that improve the quality of investment decisions and increase investment opportunities. To assess the impact of digital transformation factors on the investment potential of St. Petersburg, the structure of digital potential can be represented as a unity of three components: ICT infrastructure and access, digital government, and e-business (*Fig. 1*).

The "ICT — infrastructure and access" component refers to the level of development of communication and data transmission networks, the use of the Internet, the effectiveness of R&D, the development of the information industry, and the level of information security. Since the development of information and communication technologies plays a key role in the economy, and also stimulates economic growth by increasing the level and quality of services available, the assessment of this component is relevant.

The second component of digital potential is the "digital government". Digital government services simplify access to public services and improve the quality of their implementation. The ability to interact with public authorities in digital format is seen as a prerequisite for increasing investment activity. Within the framework of this study, the "digital government" component is an integral indicator that assesses the level of readiness and capabilities of government agencies to use ICT, as well as the level of use of digital public services by the population.

The third component that can be used to assess the level of digital potential of the city is "e-business". This is a promising direction for doing business, which increases the level of investment attractiveness and competitiveness of the city. E-business is defined as a system of the following factors:

- integration of internal IT systems and general access to the data within the organization;
- integration of the organization's IT system with the third party's IT system and e-commerce.

To assess the three components of digital potential, statistical data were used that characterize the level of development of each component (particular factors). The source of information is the data of the Federal State Statistics Service of the Russian Federation and the Federal Service Office for St. Petersburg and the Leningrad Region. The composition and values of the components of digital potential for 2018 are given in *Table. 1*.

The assessment of the integral (overall) level of digital potential occurs in the following sequence: at the first stage, statistical indicators are selected that characterize the level of digital transformation of a city (specific indicators of digital capacity). Specific indicators are grouped into three components.

During the second stage, the significance of the selected indicators of digital potential is confirmed by the degree of their influence on investment activity using the method of correlation analysis.

During the third stage, the values of specific indicators of digital potential are standardized, for which other cities of federal significance are included in the assessment and arithmetic mean values are calculated for each particular factor of digital potential. Further, the integral level of digital potential is estimated using the formula of the multivariate mean.

To assess the digital potential of St. Petersburg, the data were used for the period from 2012 to 2018. To substantiate the significance of the selected factors of digital potential, the Pearson pair correlation coefficient was calculated, which characterizes the close relationship between the indicators. The significance of the linear correlation coefficient was confirmed by *t*-staticstics. At the same time, the volume of investments in fixed assets of St. Petersburg was used as a resultant indicator characterizing investment activity. Correlation analysis showed close relationship between fifteen out of nineteen specific indicators of digital

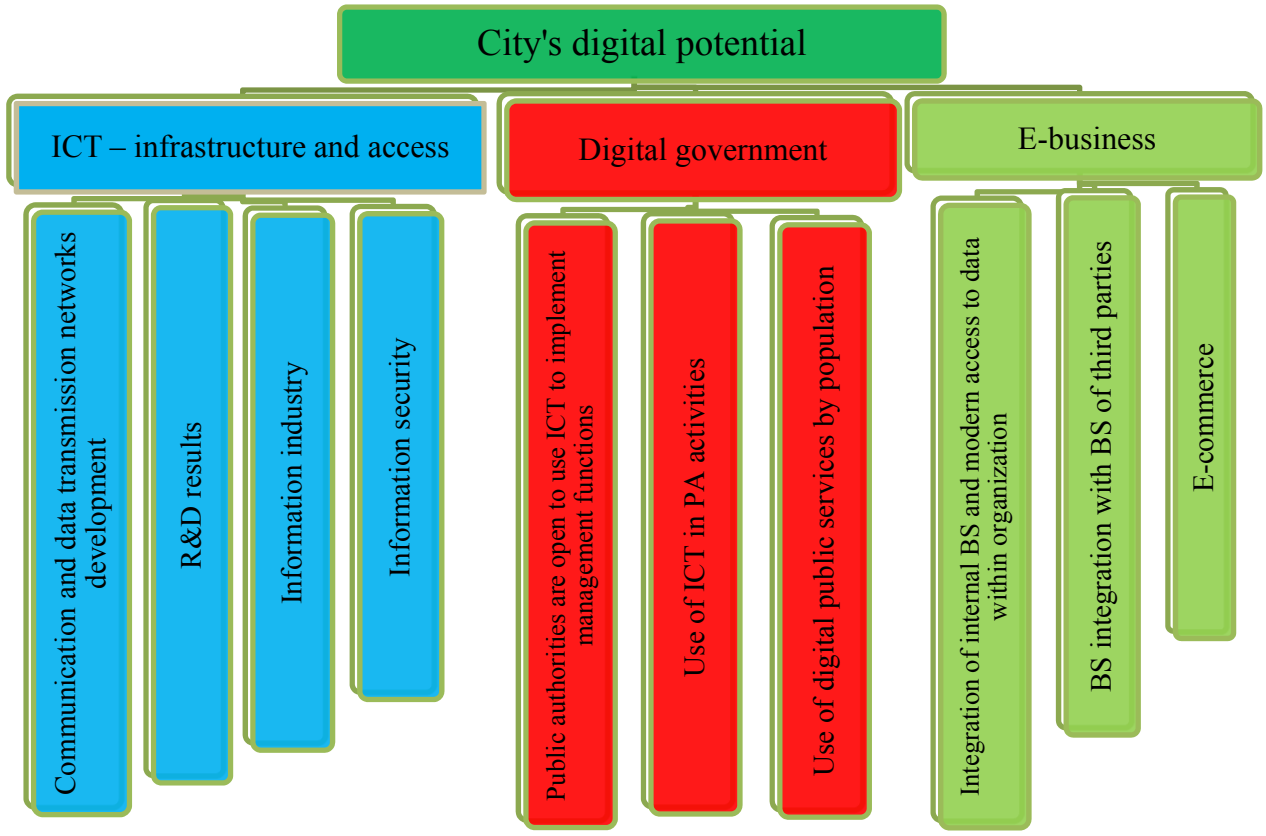

Fig. 1. **City's digital potential structure**

Source: compiled by the author.

Note: ICT — information and communication technology, PA — public authorities, BS — business system.

potential, which were further included in the assessment.

This confirmed the hypothesis of the study about the strong influence of digital potential on investment activity. Therefore, it is necessary to take into account digital factors in the composition of investment attractiveness.

Based on the values of the correlation coefficients, the following indicators have the greatest influence on investment activity in the city:

- digitalization level of the local telephone network (0.96);
- share of organizations using ERP systems (0.93);
- mobile broadband internet users per 100 people (0.91).

Three factors of innovative potential with a correlation coefficient of less than 0.2 were excluded from the study.

At the next step, standardized values of digital potential factors were calculated using specific indicators characterizing the digital transformation of two other cities with federal status — Moscow and Sevastopol (*Table 2*).

To assess the integral level of digital capacity, the values of specific indicators were integrated according to the formula of the multivariate mean:

$$M_i = \frac{\sum_{n=1}^{m} k_n \frac{Pni}{\overline{Pn}}}{\sum_{n=1}^{m} k_n} \quad (1)$$

where M_i — the integral value of the city's investment potential level, comparable with the average level of the value for the cities with federal status, taken as 1.00; $i = 1,\ldots, k$ — total number of cities under study; m — specific

Table 1

Specific factors (indicators) of the city's digital potential in 2018

Component	Indicators	Name of variable	Value 2018	
			St. Petersburg	Russia
ICT — infrastructure and access	Digitalization level of the local telephone network, %	X_{u1}	82	94
	Fixed broadband internet users per 100 people	X_{u2}	29.3	21.7
	Mobile broadband internet users per 100 people	X_{u3}	108.2	86.2
	Fixed assets investment used to purchase information, computer and telecommunication equipment, million rubles	X_{u4}	26 514	484 035
	Share of Internet users in the total population	X_{u5}	0.93	0.87
	Share of ICT sector employees in the total employed population, %	X_{u6}	3	1.6
	The share of organizations that used tools for protecting data transmitted over global networks — encryption, electronic signature, digital signature	X_{u7}	0.844	0.893
	Share of the population not using Internet for security reasons, %	X_{u8}	0.3	0.4
	Share of organizations implementing technological innovations in the total number of surveyed organizations	X_{u9}	0.37	0.20
Digital government	The share of the population using the Internet to receive public and municipal services in the total population that received the services, %	X_{u10}	69.9	74.8
	Share of electronic document flow between public authorities	X_{u11}	0.506	0.501
	Share of the population using the Internet to receive public and municipal services	X_{u12}	0.44	0.45
E-business	Share of organizations using ERP systems, %	X_{u13}	19.5	13.8
	Share of organizations using CRM systems, %	X_{u14}	17.9	13.2
	Share of organizations using electronic document management systems, %	X_{u15}	68.5	68.6
	Share of organizations using electronic data exchange with external information systems via exchange formats, %	X_{u16}	73.7	64.9
	Share of organizations using SCM systems in the total number of surveyed organizations, %	X_{u17}	5.7	6.4
	The share of organizations that placed orders for goods (works, services) via the Internet	X_{u18}	0.49	0.42
	The share of organizations that received orders for goods (works, services) via the Internet	X_{u19}	0.317	0.225

Source: compiled by the author based on the Federal State Statistics Service.

Table 2

Normalized/ Standards values of specific indicators in 2018

Specific indicators of digital capacity	Cities with federal status		
	St. Petersburg	Moscow	Sevastopol
$X_{ц1}$	0.904	1.092	1.004
$X_{ц2}$	1.338	1.404	0.257
$X_{ц3}$	1.422	1.539	0.038
$X_{ц4}$	1.279	1.710	0.011
$X_{ц5}$	1.084	1.084	0.831
…	…	…	…
$X_{ц15}$	1.154	1.143	0.703
Хц	1.08	1.19	0.70

Source: the author's calculations.

indicators; P_m — numerical value of *n* indicator for *i* — city; $\overline{Pn}$ — numerical value of *n* on average in cities with federal status; *Kn* — the total set of all integrable specific indicators for this factor.

The table shows the results of calculating the integral level of the digital capacity of St. Petersburg for 2016–2018 (*Table 3*).

According to the *Table. 3*, the components "ICT infrastructure" and "E– business" in St. Petersburg are at a high level. This suggests that the city has a highly developed level of digital activity. Thus, the indicator of the value of fixed broadband access per 100 people in 2018 in St. Petersburg is 29.3 of all households, in Moscow — 36, in Sevastopol — 6.6, with an average level in Russia of 21.7 (*Fig. 2*). It should be noted that the growth of fixed broadband Internet access is significantly lower than mobile access due to the possibility of being mobile and always connected for users. However, the high level of these indicators influenced the value of the ICT infrastructure component, as they complement each other.

The level of digitalization of the telephone network in St. Petersburg is growing every year and as of 2018 is 81.8%. The level of digitalization of the telephone network is closely related to the possibility of using high-speed Internet (*Fig. 2*).

The level of the "E-business" component was significantly influenced by the high values of the e-commerce indicator — 49% of the total level of digitalization in 2018, while the average indicator for Russia is 42%.[8] In addition, its level depends on the level of intranet (integration of IT systems within organizations) and extranet (integration of IT systems with third parties) use. Generally, in terms of the level of intra- and extranet development, St. Petersburg scores higher the average across Russia but lower than Moscow. The share of organizations using ERP and CRM in Moscow, on average for the period from 2016 to 2018, is, respectively, 21.5 and 19.5%, while in St. Petersburg this indicator is lower — 19.5 and 17%. The share of organizations using electronic data exchange between their own and external systems on average in Russia, in 2018 — 64.9%, in Moscow — 78.2%, in St. Petersburg — 73.7%.

The "Digital government" component is in the third place. This is due to the lower values of indicators in the composition of the component in comparison with Moscow and indicators of other components of digital potential. For example, the share of the population who received public services in St. Petersburg in the period

[8] Hereinafter — by the Federal State Statistics Service. URL: https://rosstat.gov.ru/folder/14478?print=1 (accessed on 10.08.2020).

Table 3

Integrity level of the digital potential

Period	ICT infrastructure	Digital government	E-business	Integrity level of the digital capacity
St. Petersburg				
2018	1.15	0.94	1.16	1.08
2017	1.13	0.93	1.15	1.07
2016	1.13	0.91	1.10	1.05
Moscow				
2018	1.35	1.22	1.17	1.25
2017	1.35	1.26	1.16	1.26
2016	1.33	1.21	1.17	1.24
Sevastopol				
2018	0.49	0.87	0.72	0.69
2017	0.47	0.85	0.65	0.66
2016	0.38	0.81	0.59	0.59

Source: the author's calculations.

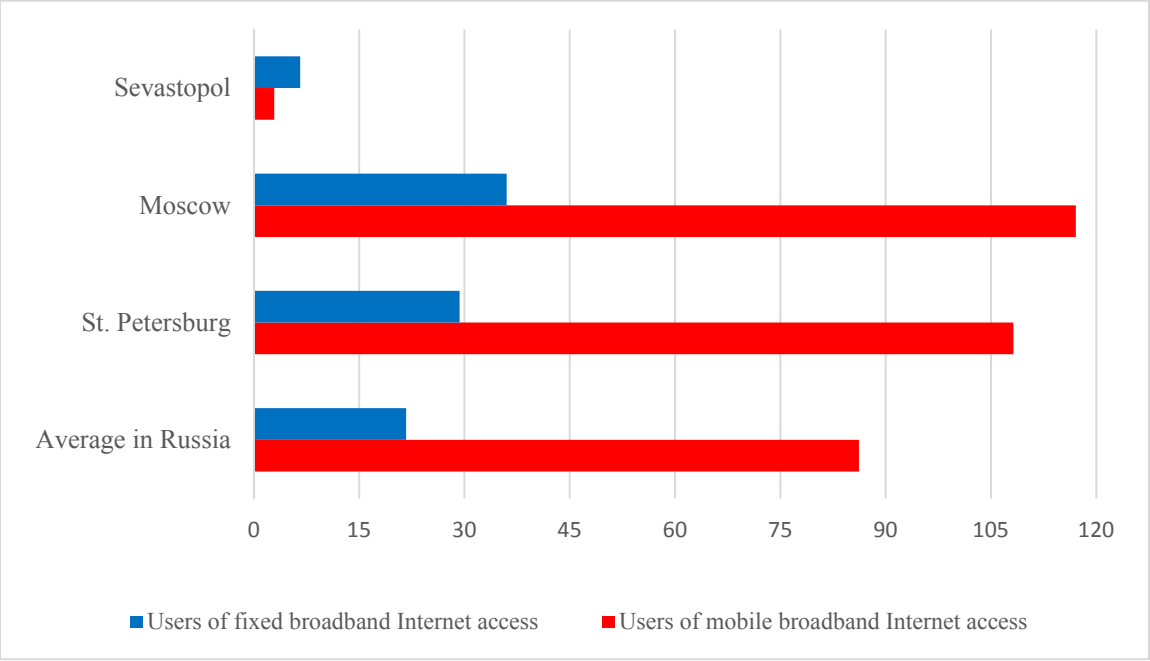

Fig. 2. **Internet users per 100 people**

Source: compiled by the author based on the Federal State Statistics Service. URL: https://rosstat.gov.ru/folder/14478?print=1 (accessed on 10.08.2020).

from 2016 to 2018 is 58.6; 69.9; 77.5%, respectively, versus 71.3; 80; 83.2% of the values of similar indicators in Moscow. At the same time, the possibility of using electronic document management systems, the Digital government service, together with the investment portal in St. Petersburg, contribute to reaching the full investment potential of the city.

CONCLUSIONS

Digital transformation is an integral part of the changes taking place in all the countries of the world. The impact of digitalization on the economy and investment attractiveness of the Russian cities in recent years has significantly increased and, obviously, will continue growing, as the introduction of information and communication technologies in various areas is one of the priorities of the state policy in Russia. For an objective ranking of the Russian cities by the level of investment capacity and the impact of digitalization on investment activity, it is necessary to consider digital factors as part of the investment attractiveness, which are grouped into three categories: information and communication infrastructure, digital government, and e-business. When developing a methodology for assessing the digital potential of territorial entities, it is important to use correlation analysis to substantiate the influence of the selected statistical indicators, considered in the capacity composition, on the level of fixed assets investment. At the same time, the methodology itself can be based on previously developed algorithms used by theorists and practitioners to assess the level of investment attractiveness of the Russian cities.

The assessment of the digital potential of the Russian cities allows us to conclude that St. Petersburg has been showing moderate growth in the digital capacity over the past three years. The city predictably ranked second on digital potential, and the first place was kept by the capital of Russia. This is the expected result. Moscow is leading in terms of ICT implementation in the urban environment and its use by the population, which is reflected in the higher value of all the digital potential components.

Sevastopol, the capital of the Crimean federal district, which joined Russia in 2014, is in the third place. The digital transformation indicators of Sevastopol are significantly inferior to those of Moscow, St. Petersburg, and the average values for the regions of the Russian Federation. For example, the level of mobile Internet use by the population in 2018 is ten times lower than in Moscow and on average in cities of the Russian Federation. This difference of indicators led to a significant decrease in the level of a comprehensive assessment of the "ICT infrastructure" component and, as a result, to a low level of the digital potential of Sevastopol.

The decrease in the integral level of the digital potential of St. Petersburg was influenced by the "Digital government" component, which shows the lower level of use of electronic public services by the population compared to other cities with federal status, despite the ongoing digitalization processes in these services. Thus, a promising area that contributes to increasing the digital potential of St. Petersburg is the use of digital channels of interaction with authorities, the integration of IT systems within organizations, as well as the active use of electronic document management systems.

In conclusion, it should be noted that the obtained results are divided into two blocks: on the one hand, a methodology for assessing the digital potential of the Russian cities in the economy is proposed, its approbation is carried out, and the received results reflect the differences of cities in terms of the level of use of digital technologies. On the other hand, the necessity of including digital potential in the assessment of investment attractiveness has been substantiated. The development of the methodology for assessing investment attractiveness, taking into account digital factors as part of the investment potential, will consider the impact of digital

transformation on the socio-economic growth of regions of the Russian Federation, as well as receive updated investment attractiveness rating of regions. The materials presented in the article may be useful to Russian and foreign scientists; credit rating agencies; civil servants. Future studies on the current topic should focus on clarifying the specifc indicators of digital potential, expanding the research base (assessing the investment potential by the federal districts of the Russian Federation), clarifying the methodology for assessing the investment attractiveness of a territorial entity.

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The article was submitted on 14.08.2020; revised on 28.08.2020 and accepted for publication on 01.09.2020.
The author read and approved the final version of the manuscript.