Socio-economic digitalisation development in the Volga federal district regions of Russia

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Abstract. Competent and effective management of the processes of digitalisation of socio-economic development of regions requires the development of system-integrated monitoring methods designed to track key spheres of social life. The assessment of the level of digital transformation of territories is the main means of this monitoring. This article proposes the author's methodology for calculating the integral index of the level of digitalisation of socio-economic development of the subjects of the Russian Federation. The object of the study is the process of digitalisation of the Volga Federal District of the Russian Federation. The proposed methodology can be applied to annual monitoring of digitalisation of Russian regions in three key areas. The findings allow us to assess the degree of progress and changes in the digitalisation of the regions over certain periods of time. This methodology can serve as an important tool for identifying achievements and shortcomings in the development of digital technologies in the socio-economic sphere.

1 Introduction

While traditional factors of production included physical assets such as buildings and machinery, the era of globalisation and technology highlights the growing importance of intangible productive forces such as human capital, information, communication and digital technologies [1-3]. It is vital for science and practice to actively research, develop and promote these technologies. In addition, it becomes important to assess their impact on the creation of socio-economic effects both at the intermediate (sectoral and sectoral levels) and higher (regional and national) levels [4, 5].

Nowadays, both in the world in general and in Russia in particular, there is a transition from the fifth technological mode of socio-economic development to the sixth one, which is characterised by changes in the key factors of production [6, 7]. While the core of the fifth technological mode includes the electronics industry, computing and fibre optics, telecommunications, robotics and mechatronics, software and some information technologies, primarily related to computerisation, the core of the sixth technological mode consists primarily of various end-to-end information technologies (big data, quantum technologies, wireless communication technologies, neurotechnologies and artificial

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intelligence, distributed registry systems, technologies for the development of information technologies, and other technologies).

Russia currently attaches great importance to digitalisation and the digital economy. The degree of digitalisation now plays a crucial role in determining the global competitiveness of the country and its regions. For the Russian Federation and its constituent entities to achieve higher levels of economic growth in the current economic environment, it needs innovative achievements and its own scientific solutions. The need to implement digital technologies stems from their significant impact on various socio-economic spheres, including industrial production, trade, transport, financial services, education, healthcare, culture and media [8-10]. These technologies open up new opportunities for individuals and organisations in various sectors, laying the foundation for the creation and dissemination of new ideas, advances and innovations in business and other activities [11, 12].

The products of the information and communication technology sector are becoming more and more accessible every year, resulting in their widespread distribution among users. As a result, digital technologies can horizontally penetrate all socio-economic systems, covering companies, industries and organisations [13, 14]. This creates inclusive platforms that can host a variety of application solutions for a wide range of applications. The interactions between different digital technologies give rise to new production technologies and innovative ways of utilising them. Moreover, the interaction of these new technologies generates subsequent derivative effects of a similar nature [15-17].

The study and systematisation of points of view found in the scientific literature regarding the definition of "digitalisation" allows us to identify two main approaches. In the first approach, this concept refers to the transformation of analogue information into a digital format. In the second approach, digitalisation is defined as the process of penetration of digital technologies into business, economic and social spheres. This penetration leads to higher labour productivity, lower costs, increased economic efficiency of economic entities and, ultimately, strengthened competitiveness. Consequently, a synergistic effect is created, contributing to the development of regional and national economic systems.

Our point of view suggests that the digitalisation of the regional economy entails the integration of information, communication and digital technologies into the economic processes of the region. This integration is conditioned by global and national trends of digital transformation and the need to organically fit the socio-economic system of the region into the standards set by the sixth technological mode.

Prominent economists and experts agree that digitalisation is the main factor in increasing competitiveness at the regional and national levels. This importance is intentional as digitalisation helps to achieve vital socio-economic development goals such as improving the quality of life [18, 19], achieving balanced and sustainable development, promoting social progress, increasing human capital and ensuring environmental well-being [20-22]. This development paradigm, known as inclusive economic growth, is characterised by these effects.

The proliferation of digital technologies generates a range of effects encompassing both positive and negative aspects. On the positive side, it creates conditions for economic growth, improves service quality and reduces the cost of production. Conversely, it also creates risks, such as potential job losses, increased inequality and increased threats to information security. Careful monitoring of these transformations is necessary, which raises the task of information and analytical support for the management of the digitalisation process at the national, regional and sectoral levels [23].

In this regard, the purpose of the study is to develop and practical application of the author's methodology for assessing the level of digitalisation of socio-economic development of the region, including three analytical blocks of assessment: digital population, digital social sphere, digital economy.

2 Materials and methods

The following methods are used in this work - comparative analysis, method of indexation and ranking, method of comparative analysis.

Let us present the analysis algorithm used to calculate the integral indicator within the framework of this study.

To begin with, it is necessary to define the categories of indicators considered for assessing sustainable development. In our study, these categories cover indicators related to the use of information and communication, digital indicators by the population, subjects of the social sphere and the economy. The information basis of the study was made up of data from the Federal State Statistics Service, as well as Internet resources such as Rosstat and the Unified Interdepartmental Information and Statistical System (EMISS). We will now take a closer look at the statistical indicators used in this study to assess the level of digitalisation of the region's socio-economic development, with a focus on the digital aspect (Fig. 1).

The Digital Social Sphere subindex assesses the level of digitalisation of social spheres such as education, healthcare and culture in the region. It includes the following indicators:

- connectivity of educational institutions to the Internet and the use of personal computers for educational purposes;
- the use of distance education technologies in basic educational programmes;
- the prevalence of Internet access among employees of health care institutions via personal computers;
- availability of websites of health care institutions, which increase the accessibility of information to the public;
- use of the Internet in cultural institutions to expand and improve their activities;
- availability of websites of cultural institutions, which facilitates communication with the audience and increases the accessibility of cultural activities.

This sub-index helps to assess how effectively the region applies digital technologies in education, health and culture to ensure the improvement of the quality of life and development of its inhabitants.

The Digital Economy sub-index measures the level of digitalisation in the region's economic sphere and consists of six key indicators:

- information protection: reflects the use of information protection tools for data transmission over global networks in organisations;
- procurement management: assesses the availability of special software tools for managing procurement of goods, works and services in organisations;
- Internet connection in the organisations: reflects the number of personal computers with Internet access for every 100 employees of the organisations;
- electronic data exchange: reflects the share of organisations that use electronic data exchange between their own and external information systems by exchange formats;
- Internet use by employees: reflects the proportion of employees in organisations who regularly use the Internet at least once a week;
- e-orders: measures the proportion of organisations that place orders for goods, works or services via the Internet;

This sub-index measures the level of digitalisation of economic processes in the region by analysing the involvement of organisations and their employees in the use of modern digital technologies and resources to improve business efficiency and competitiveness.

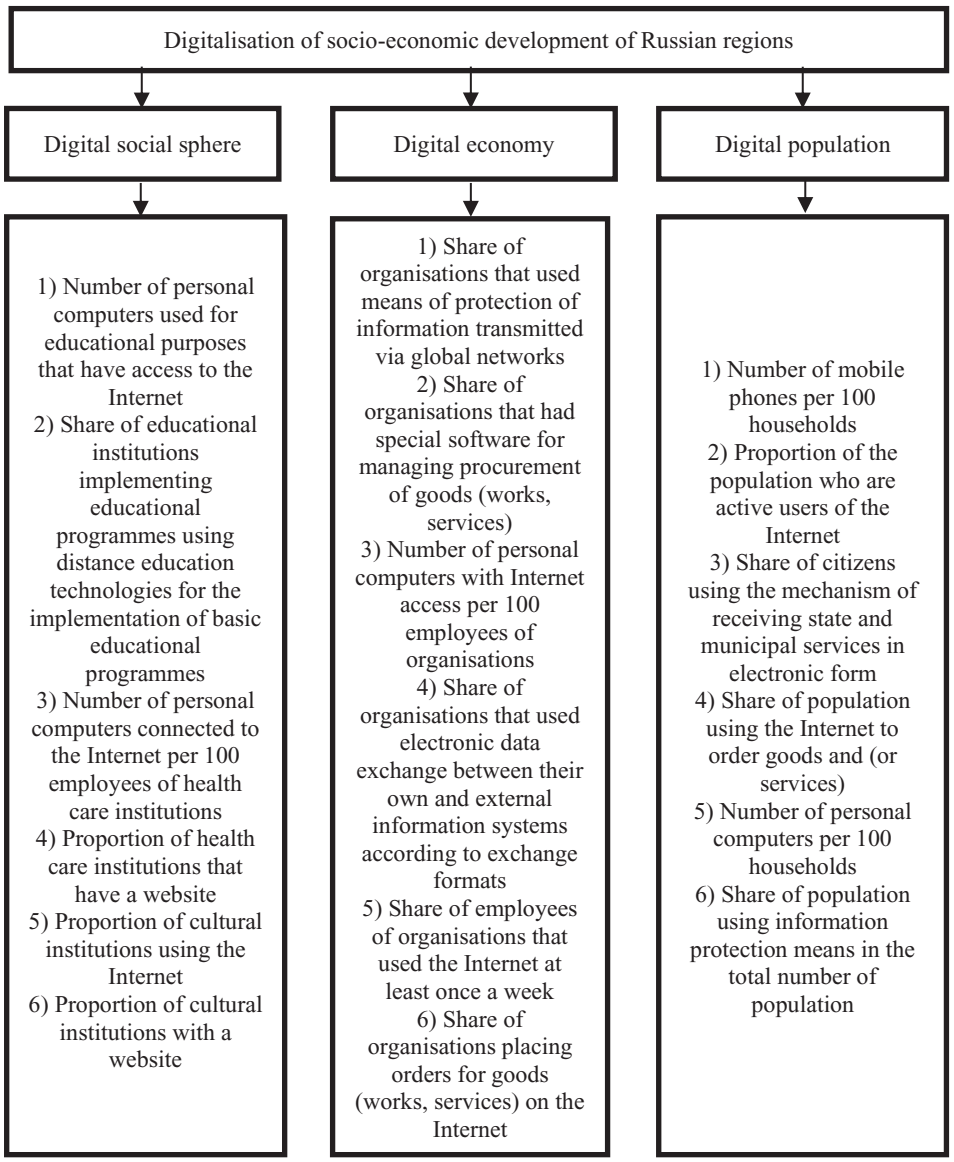

Fig. 1. Statistical indicators by blocks of assessment of the level of digitalisation of socio-economic development of Russian regions

The Digital Population sub-index assesses the level of digital literacy and digital inclusion of the region's population, and it includes the following six indicators:

- mobile connectivity: displays the availability of mobile phones for every 100 households;
- Internet users: takes into account the share of the population actively using the Internet;
- electronic public services: estimates the share of citizens who receive public and municipal services electronically;
- Internet shopping: reflects the share of the population using the Internet to order goods and/or services;

- personal computer coverage: takes into account the availability of personal computers for every 100 households;
- Data security: estimates the proportion of the population using information security tools to ensure data security;

This sub-index allows us to assess the extent to which the population of the region uses digital technologies in their everyday life, interaction with the state and business, as well as the extent to which they are aware of the need to protect their data when using the Internet and digital services.

The next step is to analyse the relationship between the digitalisation indicator and the nature of the region's socio-economic development. The digitalisation indicators are indexed with different formulas to determine their impact on the positive or negative direction of the socio-economic development of the region. In this study, all indicators are considered to influence positively the socio-economic development of the region.

The following formula is used for the direct relationship:

$$X_i = \frac{x_i - x_{min}}{x_{max} - x_{min}}$$

here X_i – index of the indicator for the i-th region in the year under consideration;

x_i – actual value of the indicator for the i-th region in the year under consideration;

x_{max} and x_{min} – maximum and minimum values of the indicator among all regions under consideration in the year under review.

Each index should fall within the range from 0 to 1, where 1 defines the region as an absolute leader in the indicator, and 0 - as an absolute outsider. After determining the values of the 18 indices, we calculate the values of three sub-indices for each block for each region. Having obtained the values of the three sub-indices, we can find the integral index. Both the sub-indices and the integral index are calculated using the simple arithmetic mean formula. The conclusion should analyse the obtained results and draw appropriate conclusions.

3 Results

Our proposed methodology for assessing the digitalisation of socio-economic development of the region was tested in this study by calculating integral indices of digitalisation of socio-economic development of 14 subjects of the Volga Federal District of Russia and subsequent comparative analysis of the results obtained. Two periods - 2015 and 2021 - were used for the assessment. In each of the two periods, the subjects of the Volga Federal District were divided into two groups depending on the value of the integral index of the level of digitalisation of socio-economic development: regions of the first group (leading regions) with an integral index value equal to 0.5 or higher and regions of the second group (outsider regions) with an integral index value below 0.5. Next, let us consider in more detail the results of a comparative analysis of the results of the assessment of the level of digitalisation of socio-economic development for the two periods.

Figure 2 shows the results of the assessment of the level of digitalisation of socio-economic development of the regions of the first group in 2015.

The Orenburg Oblast, the Udmurt Republic, the Perm Krai, the Chuvash Republic, the Republic of Bashkortostan, and the Republic of Tatarstan were identified as the regions of the first group. In 2015, four subjects among the leading regions had integral index values above 0.65.

The Republic of Tatarstan, being the leader among the regions of the middle group, has high values for the digital economy and digital population sub-indices, but lags significantly behind in the digital social sphere sub-index.

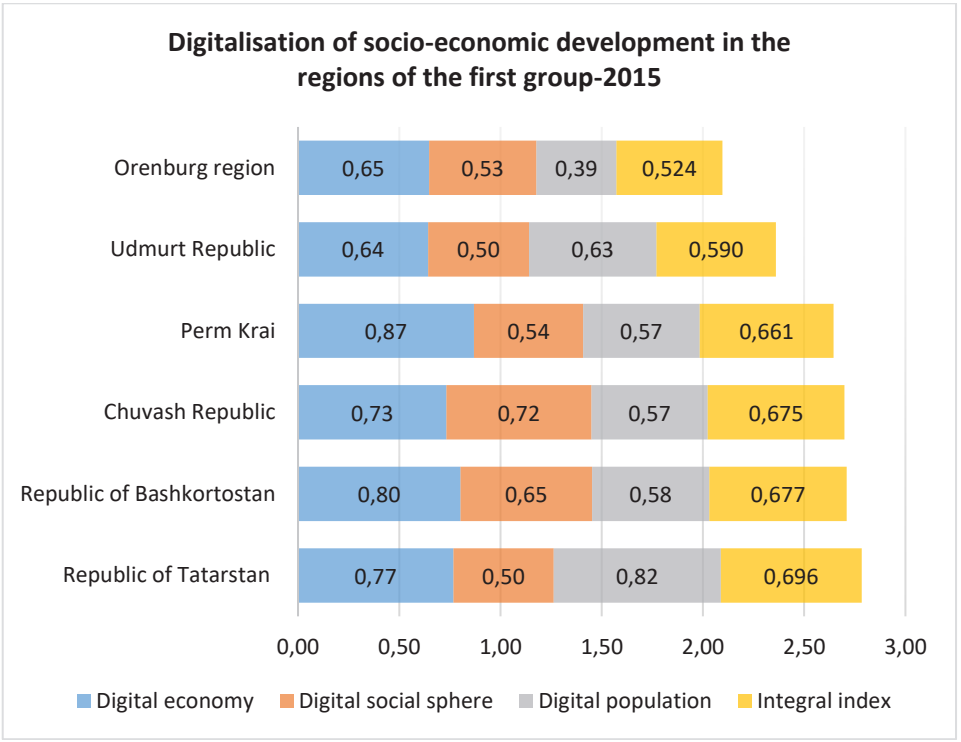

Fig. 2. Results of the assessment of the level of digitalisation of socio-economic development in the regions of the first group in 2015.

The distinctive feature of the Perm Territory, the Chuvash Republic and the Republic of Bashkortostan is relatively low values for the digital population and relatively high values for the digital economy. The Udmurt Republic has moderate values for the digital economy and digital population, but a relatively low value for the digital social sphere indicator. The Orenburg Region has a significantly low value in the digital population sub-index and a moderately low value in the digital social sphere.

Figure 3 shows the results of the assessment of the level of digitalisation of socio-economic development of the regions of the second group in 2015.

The Republic of Mordovia, Penza Oblast, Ulyanovsk Oblast, Kirov Oblast, Samara Oblast, Saratov Oblast, Republic of Mari El, and Nizhny Novgorod Oblast were identified as the regions of the second group. The Saratov Region, the Republic of Mari El and the Nizhny Novgorod Region have high values for the digital economy (above 0.5), average values for the digital social sphere (between 0.45 and 0.5) and low values for the digital population.

The ratio of subindex values in the Kirov and Samara Regions is quite different. Thus, these subjects have relatively high values for the digital population, with average values for the digital social sphere and significantly low values for the digital economy. The Penza Oblast and Ulyanovsk Oblast have low values in the areas of digital social sphere and digital population. In the Republic of Mordovia, it is worth noting the extremely low value of the digital population indicator and moderately low values of the digital economy and digital social sphere sub-indices.

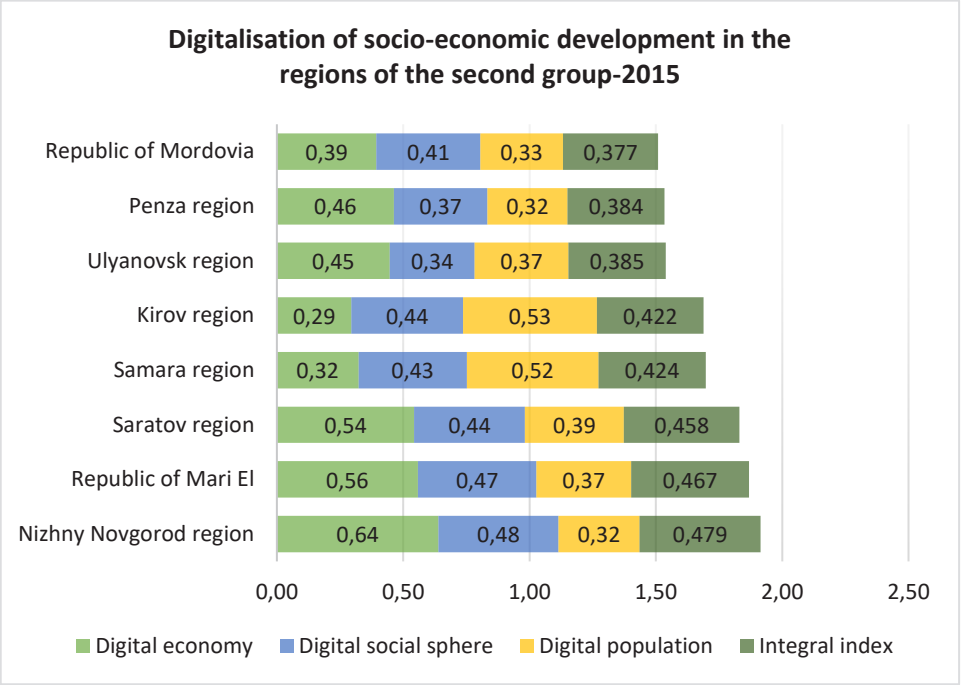

Fig. 3. Results of the assessment of the level of digitalisation of socio-economic development of the regions of the second group in 2015.

Figure 4 shows the results of the assessment of the level of digitalisation of socio-economic development of the regions of the first group in 2021.

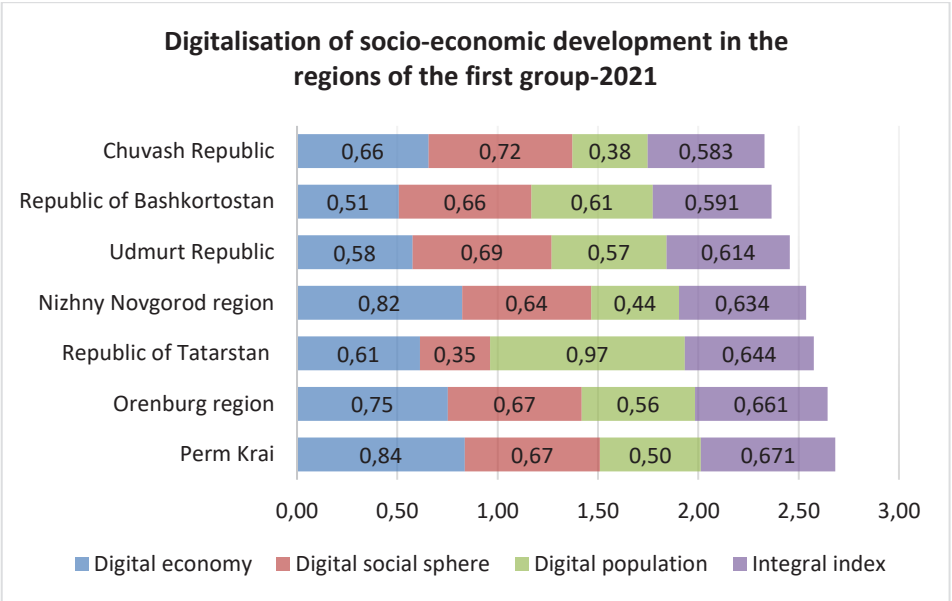

Fig. 4. Results of the assessment of the level of digitalisation of socio-economic development of the regions of the first group in 2021.

Compared to 2015, the number of leading regions has increased by one - the Chuvash Republic, the Republic of Bashkortostan, the Udmurt Republic, the Republic of Tatarstan, the Orenburg Region and the Perm Territory, which were in the first group in 2015, have been joined by the Nizhny Novgorod Region. Also in 2021, compared to 2015, the location of regions in the first group has changed. The Perm Territory was the leader, with an increase in the digital social sphere indicator, but a slight decrease in the digital economy and digital population indicators. The Orenburg Region significantly improved its position, moving up three places and improving its performance in all three areas. Despite the growth of the digital population subindex, the position of the Republic of Tatarstan among the regions of the Volga Federal District slightly deteriorated due to a significant decline in the digital social sphere indicator and a slight decrease in the digital economy indicator. The Nizhny Novgorod Region came fourth among the leading regions in 2021 due to a significant increase in the digital economy and digital social sphere sub-indices and some growth in the digital social sphere indicator. As a result of a parallel large growth in the digital economy index and a slight decline in the digital economy and digital population indices, the position of the Udmurt Republic in 2021 did not change significantly. The value of the integral index of the Republic of Bashkortostan in 2021 significantly decreased compared to 2015, which is largely due to a significant decline in the value of the digital economy subindex. The level of digitalisation of socio-economic development in the Orenburg Region in 2021 compared to 2015 improved significantly as a result of average growth in the digital economy and digital social sphere sub-indices and a significant increase in the digital population sub-index.

Figure 5 shows the results of the assessment of the level of digitalisation of socio-economic development of the regions of the second group in 2021.

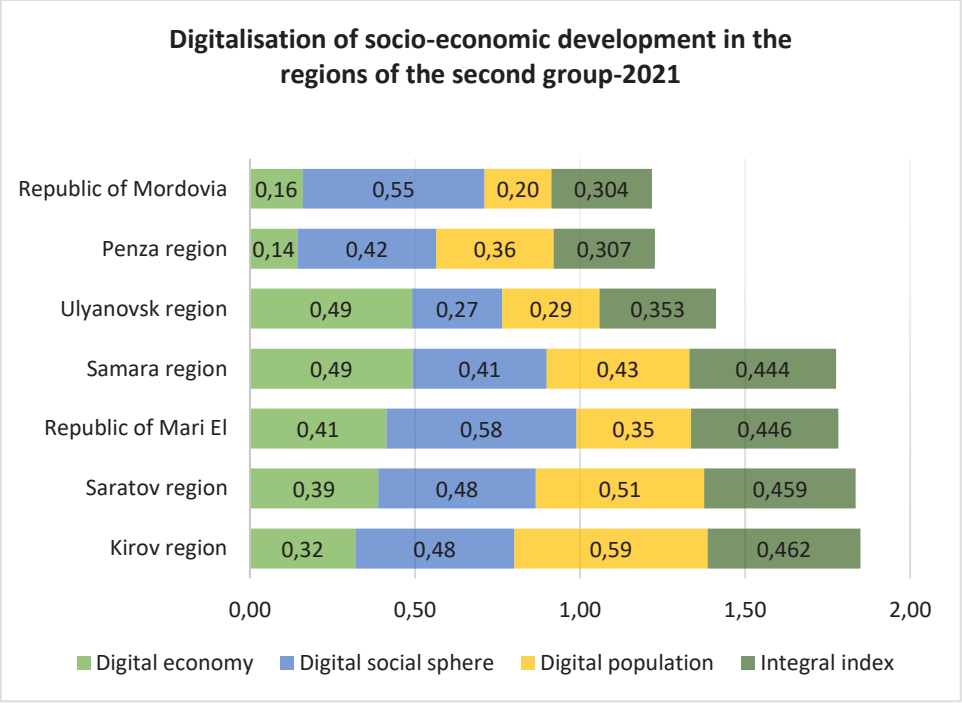

Fig. 5. Results of the assessment of the level of digitalisation of socio-economic development of the regions of the second group in 2021.

Due to a significant increase in the value of the Nizhny Novgorod Oblast integral index, the number of regions-outsiders was reduced to seven, among which there were no major

shifts in 2021 compared to 2015. Due to a slight increase in the values of all three sub-indices, the Kirov Oblast was the leader among the subjects of the second group. The Saratov Region experienced a significant decline in the digital economy with a parallel growth in the areas of digital social sphere and digital population, as a result of which the Saratov Region retained its position in 2021. The Republic of Mari El dropped several positions due to a serious decline in the digital economy and digital social sphere, despite a slight increase in the digital population. The Samara Region saw a serious growth in the digital economy, but as a result of the decline in the digital social sphere and digital population sub-indices, the Samara Region fell slightly among the regions in the second group. Despite the fact that the Ulyanovsk Region saw a slight growth in the digital economy and a decline in the digital social sphere and digital population, the Penza Region saw a decline in the digital economy and some growth in the digital social sphere and digital population, and the Republic of Mordovia saw a decline in the digital economy and a significant growth in the digital social sphere and digital population, both the Ulyanovsk Region, the Penza Region and the Republic of Mordovia retained their positions in 2021.

Thus, we assessed the level of digitalisation of the socio-economic development of the subjects of the Volga Federal District of Russia in 2015 and 2021, conducting a comparative analysis of the results obtained. In practice, we applied the author's methodology for analysing the digitalisation of socio-economic development of Russia's constituent entities with the calculation of the corresponding integral index consisting of three sub-indices - digital economy, digital social sphere and digital population.

4 Discussion

Within the academic discourse concerning the assessment of the impact of digitalisation on regional socio-economic progress, some key areas deserve careful consideration. Among them, the Smart Region model stands as a promising frontier, outlining a new stage of holistic integration of digital advances into the structure of regional socio-economic development. This model provides an overarching framework that transcends traditional paradigms by integrating digital technologies, data-driven insights, and strategic management mechanisms into a coherent whole.

The smart region paradigm fundamentally entails a paradigmatic shift in regional development strategies based on the convergence of digital innovation with the complex dynamics of governance and socio-economic structures. This convergence is expected to foster an environment in which technological breakthroughs, innovative methodologies and digital infrastructures synergise to deliver enhanced efficiency, resilience and competitiveness.

Central to the smart region model is the intelligent use of digital tools to optimise resource allocation, enhance public service delivery and improve the overall well-being of society. Key attributes include the creation of smart city ecosystems, evidence-based decision-making processes and the establishment of symbiotic partnerships between public authorities, private enterprises and civil society organisations.

The Smart Specialisation approach inherent in the Smart Region model serves as a key mechanism to drive innovative growth within regions. Based on European Union policies, this approach embodies a structured way to support regional development through a concentrated alignment of market opportunities and dynamics.

Crucially, the smart specialisation paradigm involves identifying sectors characterised by the intersection of innate competences and new market trends. By strategically targeting investments and interventions in these areas, regions can capitalise on the momentum of innovation, creating sustainable economic value and enhancing their competitiveness.

The significance of the smart specialisation approach lies not only in its ability to capitalise on local strengths, but also in its seamless integration into the smart region model. This integration combines the benefits of regional identity and inter-regional co-operation. It generates a virtuous cycle of knowledge transfer, technological cross-pollination and increased collective capacity, thereby fostering a synergistic harmony that aligns seamlessly with the broader goals of comprehensive regional digitalisation.

Thus, the Smart Region model, based on the principles of the Smart Specialisation approach, outlines an innovative trajectory for understanding and expanding the socio-economic implications of digitalisation in the regions. With this integrated framework, regions can not only utilise digital tools, but also enhance their latent potential, thereby charting a course towards adaptive technology-enabled regional development.

5 Conclusion

Thus, within the framework of the study, we have shown that in recent years there has been a major breakthrough in the socio-economic development of Russian regions in the field of digitalisation, which generally has a favourable impact on the socio-economic development of territories. The study presented the author's methodology for assessing the level of digitalisation of socio-economic development of regions, which includes three analytical blocks of assessment (digitalisation in the economy, digitalisation in the social sphere, digitalisation of households' life activities). The author's methodology was used to provide an analytical assessment of digitalisation of socio-economic development of the Volga Federal District subjects in 2015 and 2021. We found that the presented methodology can be used by the authorities for annual monitoring of both the general nature of digitalisation of socio-economic development of the Russian regions as a whole and the specifics of digital transformation of Russian regions in each of the three identified areas (economic, social, household).

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