СОЦИАЛЬНО-ЭКОНОМИЧЕСКОЕ РАЗВИТИЕ ЭКОНОМИКИ СЕВЕРА
SOCIO-ECONOMIC DEVELOPMENT OF THE NORTH ECONOMY

Инфраструктурный потенциал сухопутных территорий арктических регионов России

Infrastructural Potential of the Russian Arctic Land Territories

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Арктическая зона России в настоящий момент представляет собой наглядный пример неоднородности инфраструктурного развития регионов. Целью исследования является оценка инфраструктурного потенциала арктических регионов России. Основной проблемой данного макрорегиона является несоответствие его потенциальных возможностей, обусловленных выгодным экономико-географическим положением, высоким природным, ресурсным и производственным потенциалом, весьма низкому уровню развития инфраструктуры и малонаселенности территории. При этом реализация инфраструктурного потенциала регионов является драйвером их экономического роста и повышения качества жизни проживающего там населения. Авторским коллективом предложена методика количественной оценки инфраструктурного потенциала территорий на основе матричного анализа. Основное преимущество метода заключается в применении математического аппарата при расчетах, позволяющего устранить субъективность оценки. Базой для анализа в предлагаемой методике является совокупность статистических данных по выбранным регионам. В результате авторами выделены сбалансированные, передовые и активно развивающиеся регионы по инфраструктурному потенциалу. Количественные оценки могут быть использованы региональными органами власти в качестве базы для исследования существующих проблем регионов и оценки перспектив инфраструктурного развития территорий. В стратегических документах пространственно-территориального и регионального развития России отмечается важность выравнивания социально-экономического развития регионов. Проведенное исследование может стать платформой для поступательного развития и диверсификации региональных экономик российской Арктики в контексте комплексного целевого подхода к реализации их инфраструктурного потенциала. Продолжением научной работы станет изучение предмета исследования на муниципальном уровне.

***Ключевые слова:** Арктическая зона Российской Федерации, инфраструктура, инфраструктурный потенциал, матричный анализ, региональное развитие.*

The Arctic zone of the Russian Federation is an illustrative example of the heterogeneity of regional infrastructural development. The purpose of this study is to assess the infrastructural potential of the Russian Arctic regions. The main problem in this macroregion is the mismatch of its potential capabilities (favorable economic and geographical location, bountiful natural resources, and production potential) with a poor level of infrastructural development and sparsely populated areas. Moreover, the implementation of the infrastructural potential of the regions has driven their economic growth and improved the quality of life of the people who live there. The authors propose a method for quantifying the infrastructural potential of territories based on matrix analysis. The main advantage of the method is the application of the mathematical apparatus in the calculations, which enables an objective assessment. The basis for analysis in the proposed method is an aggregate of statistical data of selected regions. As a result, the authors identified balanced, advanced, and actively developing regions in terms of infrastructural potential. Regional authorities can use quantitative assessments as a basis for studying the existing problems of the regions and assessing the prospects for the infrastructural development of territories. The national strategic documents of the territorial and regional development emphasize the importance of aligning the socio-economic development of the regions. The study may provide a platform for the progressive development and diversification of the regional economies of the Russian Arctic in the context of a comprehensive targeted approach to realizing their infrastructural potential. The continuation of this scientific work will be the study of the subject of research at the municipal level.

Keywords: *Arctic zone of the Russian Federation, infrastructure, infrastructural potential, matrix analysis, regional development.*

Introduction

New mechanisms are being formed for managing the socio-economic development of the regions in the Arctic zone of the Russian Federation. It is necessary to study the reasons for the regional differentiation of their development. There is a clear need to find management tools to equalize the level of socio-economic development of territories [1].

The Arctic zone of the Russian Federation is a clear example of the differentiation of the development of various regions of the country.

Decree of the President of May 2, 2014 No. 296 "On the land territories of the Arctic zone of the Russian Federation" identified the regions that are fully or partially attributed to the Arctic: the Republic of Komi, the Republic of Sakha (Yakutia), the Arkhangelsk region, the Murmansk region, the Yamalo-Nenets, Nenets and Chukotka Autonomous Districts, the Krasnoyarsk Territory. In 2017, the Republic of Karelia partially entered the Arctic zone. The expert community is constantly discussing the expansion of the boundaries of the Arctic macro-region [2]. In 2017, the Republic of Karelia was partially added to the Arctic zone. Permanently discussions are ongoing among the expert community on expanding the boundaries of the Arctic macro-region [3].

Realization of the infrastructural potential of territories becomes a decisive factor in overcoming the heterogeneity of their development, overcoming the social contradictions between them, and the sustainable development of a country as a state with a federal structure [4].

The need for the development of various types of infrastructure in the Arctic territories was pointed out by many domestic and foreign scientists in their scientific works, for example, transport [5,6], energy [7], social [8], digital [9,10] and others.

Overview of conceptual approaches and research methodology

The solution of the problem of heterogeneous development of territories and inequality in the rights of citizens is currently recognized as the main task of regional policy.

According to Pchelintsev, infrastructure is of paramount importance for the territorial development of the state: in an ideal model of a market economic system, the state controls socio-economic development primarily through the construction of housing facilities, roads, ports, gas pipelines, and other infrastructure [11].

The study of infrastructural development is carried out by researchers from various scientific fields. Thus, research by experts in geographical science is distinguished by a spatial approach to the research objects, in which the territory is often considered as a resource base, a kind of “carrier” of infrastructure [12]. For example, Maergoise defined infrastructure as a general fund base of the territory as a system of spatially expressed elements of a material and technical nature, which together form the most general economic prerequisites in any region [13].

An analysis of the literature on the research of the concept of infrastructural potential showed that there is currently no unified approach to determining its essence. We view the meaning of the term *infrastructural potential* as an aggregate indicator that is revealed in the synergy of the following three basic values.

Firstly, infrastructural potential is a comprehensive indicator that characterizes the result of the economic development of a certain territory. This semantic meaning of the potential can be described as "resultant".

Secondly, the infrastructural potential is a combination of funds, the availability of certain resources that have already been created in the past in a certain territory, which are needed to achieve the goal. This approach is the most common in most studies of potentials. In our opinion, it is incorrect to characterize the concept of potential only by the pooling of available resources, since this leads to a copying of the concept of resources. Nevertheless, the concept of potential obviously includes a large combination of available resources. This semantic meaning of the potential can be described as "resourcing".

Thirdly, the concept of potential is often regarded as a kind of "opportunity" or ability to achieve the desired result, which manifests itself with a certain degree of probability. This approach can be called "probabilistic" [14].

The meanings of the concept of infrastructural potential is presented in Figure 1.

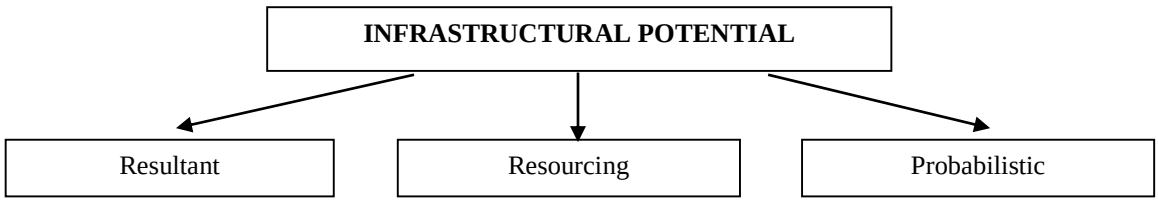


Fig. 1. Meanings of the concept of infrastructural potential

To calculate the infrastructural potential of the territory, the data presented in Figure 1 are of great practical importance because they can be used both in mathematical and methodological terms.

A quantitative assessment of the infrastructural potential of the territory requires a complex approach and an integrated assessment of the set of socio-economic indicators characterizing the probabilistic, resultant, and resource values of the potential.

Infrastructural potential can be considered as opportunities of a certain territory (country, region, municipality, etc.). In this regard, it is necessary to determine the concept of territory.

Alaev's conceptual and terminological dictionary defined a territory as a limited part of the earth's surface with its natural and anthropogenic properties and resources characterized by its extension (square) as a special kind of "spatial" resource, geographical location and other qualities, which is the subject of a specific activity or study [15].

The infrastructural potential of the territory is not only the result of its economic exploration, but also a factor in its future development. Therefore, the systematic implementation of the infrastructural potential of the regions becomes the main goal of regional development.

In order to determine the methodological approaches to assessing the infrastructural potential, it is necessary to consider the existing and applied in practice methods. The representatives of the technical sciences, as well as economists and economic geographers, study the assessment of the potential of various territorial systems.

In their work on the methodology for assessing the natural resource potential, Korytny, Bezrukov, and Savelyeva considered three basic methodological approaches to assessment: the natural expression of the qualitative and quantitative parameters of resources, the relative (comparative) approach, and the economic (absolute) approach to assessment. They noted that the total potential of a territory is determined by summing up the component natural resource potentials; its structure for administrative districts is calculated, the resource endowment of population (per 1000 people) is identified and the density of potentials (per 1000 square kilometers of the territory) is revealed [16].

Economists assess potential using methods based on economic and statistical dependencies to assess potential, thus analyzing the resource multivariate model and comparative characteristics. [17].

Makarenko and Kovalchuk proposed using the theory of fuzzy sets to assess the resource potential of the territorial economic system. The essence of this method is to evaluate a qualitative concept with a function similar to probabilistic functions, and then use this concept as an exact one. They argued that this method avoids an excessive desire for accuracy, which can have a negative effect in assessing potential [18].

Thus, there is currently no unified accepted methodology for assessing the infrastructural potential of a territory. Extant techniques are not complex. Therefore, within the framework of current research, we propose a new methodology for assessing the infrastructural potential of a territory.

Research Methodology

Having analyzed the existing methods for assessing the potential of socio-economic systems, ordering an array of indicators that characterize the infrastructural potential, we can propose a new method for quantitatively assessing the infrastructure potential of the territory.

Many sources for assessing infrastructural potential propose using a qualitative or descriptive assessment rather than a quantitative one. In our opinion, however, the concept of potential is an exact mathematical quantity, and therefore requires a mandatory quantitative assessment.

The index of the level of infrastructural development of the region was calculated on the basis of 28 indicators selected in eight groups in accordance with the typology of species of infrastructure. In turn, the index of conditions for the infrastructural development of the region includes 13 indicators in four groups characterizing the most important factors affecting the development of territorial infrastructure (Table 1).

Table 1

Indicator framework for calculation of Indexes*

Indicators of the Index of Regional Infrastructural Development (Iid)	
Type of infrastructure	*Indicator name*
1	*2*
1. Transport and transport communications	1.1 Density of railways, kilometers of tracks per 10,000 km^2
	1.2 Density of automobile surfaced roads in general use, kilometers of tracks per 10,000 km^2
	1.3 Ratio of automobile surfaced roads in the total length of public roads,%
	1.4 Volume of transport services per capita, rubles
2. Telecommunications and Information and Communication Technologies (ICT)	2.1 Number of connected mobile subscriber devices per 1000 persons of population, units
	2.2 Share of organizations using the Internet with broadband access, % of the total number of organizations
	2.3 Share of the population using the Internet every day or almost every day, % of the total population
	2.4 Share of funds in the field of information and communication in the total volume of fixed assets, %
	2.5 Volume of telecommunication services per capita, rubles
3. Energy communications	3.1 Electricity production per capita, million kWh/person
4. Digital (information) infrastructure	4.1 Length of the channels formed by digital transmission systems per 1000 km^2, thousand channel-kilometers
	4.2 Digitalization of the local telephone network, %
	4.3 Number of active subscribers of fixed broadband Internet access per 100 persons of population, units
	4.4 Number of active subscribers of mobile broadband Internet access per 100 persons of population, units
5. Innovative infrastructure	5.1 Number of techno-parks and innovative industrial clusters per municipality, units
	5.2 Ratio of organizations engaged in technological, marketing and organizational innovations in the total number of organizations (innovative activity of organizations), %
6. Social infrastructure	6.1 Number of higher educational institutions and scientific organizations (including branches) per 1000 students, units
	6.2 Number of organizations engaged in educational activities on educational programs of primary, basic and secondary general education per 1000 students, units
	6.3 Number of organizations engaged in educational activities on educational programs of preschool education per 1000 pupils, units
	6.4 Number of hospital beds per 10,000 people, units
	6.5 Capacity of dispensary and health organizations per 10,000 people, visits per shift
	6.6 Number of doctors of all specialties per 10,000 people, people
	6.7 Number of nurses per 10,000 people, persons
	6.8 Number of sports facilities (stadiums with more than 1500 seats, planar sports facilities, sports halls, swimming pools) per 1000 persons of population, units

End of the Table 1

1	*2*
7. Tourist infrastructure	7.1 Number of cultural heritage sites included in the register per 1000 km², units
	7.2 Number of organizations and enterprises by type of economic activity "hotel and catering activities" per 1000 km², units
8. Ecological infrastructure	8.1 Proportion of organizations that have reduced environmental pollution by implementing innovations that ensure increased environmental safety in the production of goods, works and services, %
	8.2 Proportion of captured and neutralized air polluting substances in the total amount of waste polluting substances from stationary sources, %
Indicators of the Index of Regional Infrastructural Development Conditions (Icid)	
Term (factor)	*Indicator name*
1. Spatial and territorial planning, capturing of the territory	1.1 Population density, people/km²
	1.2 Number of municipalities per 1000 km²
	1.3 Proportion of urban population in the total population (level of urbanization of the territory), %
	1.4 Share of industrial, energy, transport, communications, broadcasting, television, computer science, land for space activities, defense, security and other special-purpose lands in the general land fund, %
	1.5 Share of the total area of residential and non-residential buildings put into operation per square of the territory, %
	1.6 Number of own cars per 1000 people, units
2. Economics	2.1 GRP per capita, rubles
	2.2 GRP energy intensity in current prices, kilogram of standard fuel/10,000 rubles
	2.3 Investments in fixed assets per capita, rubles
	2.4 Number of operating construction organizations in the region, units/1 000 km²
3. Nature / climate	3.1 Share of the territory not covered by permafrost, %
4. The development of science and technology	4.1 Coefficient of inventive activity (the number of domestic patent applications for inventions filed in Russia per 10,000 people), units
	4.2 Percentage of population occupied by inventive activity in total population, %

Source: Compiled by the authors based on data: 1. Regiony Rossii [Regions of Russia]. Social'no-ekonomicheskie pokazateli 2019 goda [Socio-economic indicators. 2019]. *stat.sb Rosstat. Moskva.* [stat.coll. Rosstat. Moscow], 2019. (In Russian); 2. Unified Interdepartmental Information and Statistical System (EMISS). Available at: https://fedstat.ru/ (Accessed: 10.09.2020); 3. Federal'naya sluzhba gosudarstvennoj registracii kadastra i kartografii (Rosreestr) [Federal Service for State Registration of Cadastre and Cartography (Rosreestr)]. Available at: https://rosreestr.ru/site/ (Accessed: 10.09.2020). (In Russian); 4. Pyatyj ezhegodnyj obzor "rossijskie tekhnoparki — 2019" [Fifth Annual Review "Russian Technology Parks — 2019"] (In Russian).

Matrix analysis of the status of infrastructural potential was carried out according to the following algorithm.

Stage 1: Calculation of the Index of the indicator of regional infrastructural development (Qmij)

To assess the level of infrastructural development of the regions, statistical data were selected for the indicators of the regional infrastructural development index (m1, m2, m3, ..., mi) presented in Table 1 for the year 2018. To calculate the index of the indicators of infrastructural development of each region, Formula (1) was used.

$$Q_{m_{ij}} = \frac{x_j}{k_{max}}, \qquad (1)$$

where xj — value of the indicator of infrastructural development of j-region;

kmax — the maximum value of the indicator of infrastructural development in the aggregate of all studied regions.

Stage2: Calculation of the Index of infrastructural development of the region (Iid) according to Formula (2):

$$Iid_j = \frac{(Q_{mij_1}+Q_{mij_2}+\cdots+Q_{mij_{28}})}{28}, \qquad (2)$$

Stage 3: Calculation of an Index of an indicator of the conditions of regional infrastructural development (Pnij).

To assess the conditions for the infrastructural development of the regions, statistical data were selected for the index of the conditions for the infrastructural development of the region (n1, n2, n3, ..., ni) presented in Table 1 for the year 2018. To calculate the index of the indicator of the conditions of infrastructural development of each region, Formula (3) was used.

$$P_{n_{ij}} = \frac{y_j}{k_{max}}, \qquad (3)$$

where yj — value of the indicator of the conditions of infrastructural developmentof j-region;

kmax — the maximum value of the indicator of the conditions of infrastructural development in the aggregate of all studied regions.

Stage 4: Calculation of the index of conditions for infrastructural development of the region (Icidj) according to Formula (4):

$$Icid_j = \frac{(P_{mij_1}+P_{mij_2}+\cdots+P_{mij_{13}})}{13}, \qquad (4)$$

The matrix makes it possibleto group the Arctic regions according to the level and conditions of infrastructural development, which further simplifies the process of developing recommendations to state authorities on the management of regions.

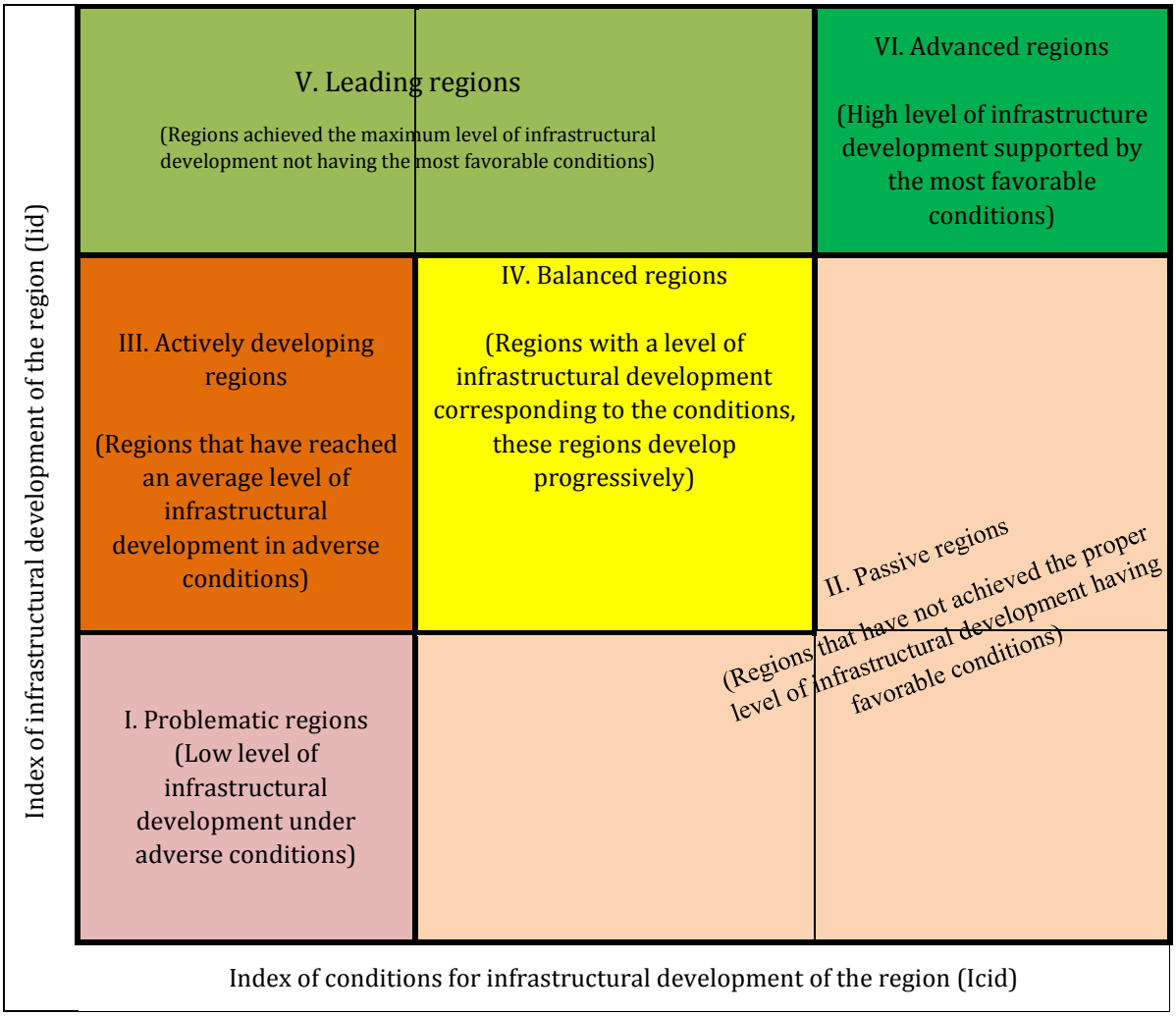


Fig. 2. Matrix of types of infrastructural potential

Therefore, the proposed methodology allows a comprehensive assessment of both the level of infrastructural development of the region and the conditions formed for the development of infrastructure in this territory. Moreover, based on the assessments obtained, it is possible to determine the main types of regional infrastructural potentials and identify their specific features, both in positive and negative aspects.

Research results

The basis for analysis in the proposed methodology was a set of statistical data on the constituent entities of the Russian Federation with the territories in the Arctic zone.

Approbation of the authors' methodology made it possible to assess the infrastructural potential of the Arctic regions of Russia in 2018.

The results of the research are presented in Table 2.

Table 2

Values of integral indexes for assessing infrastructural potential

Region	***Complex assessment of infrastructure potential***		
	Index of Infrastructural Development Level (Iid)	*Index of Conditions of Infrastructural Development (Icid)*	*Type of regions by infrastructural potential*
1. Republic of Karelia	0.71	0.55	«leading region»
2. Komi Republic	0.60	0.47	«balanced region»
3. Nenets Autonomous Okrug	0.46	0.42	«balanced region»
4. Arkhangelsk region	0.63	0.60	«leading region»
5. Murmansk region	0.62	0.47	«leading region»
6. Yamal-Nenets Autonomous Okrug	0.60	0.30	«actively developing region»
7. Krasnoyarsk region	0.60	0.42	«balanced region»
8. The Republic of Sakha (Yakutia)	0.58	0.29	«actively developing region»
9. Chukotka Autonomous Okrug	0.61	0.22	«leading region»

According to the results of the assessment, the "leading regions" group became the largest. It includes the Republic of Karelia, the Arkhangelsk Region, the Murmansk Region and the Chukotka Autonomous Okrug. These regions have reached a high level of infrastructural potential without having the most favorable conditions, which deserves high marks.

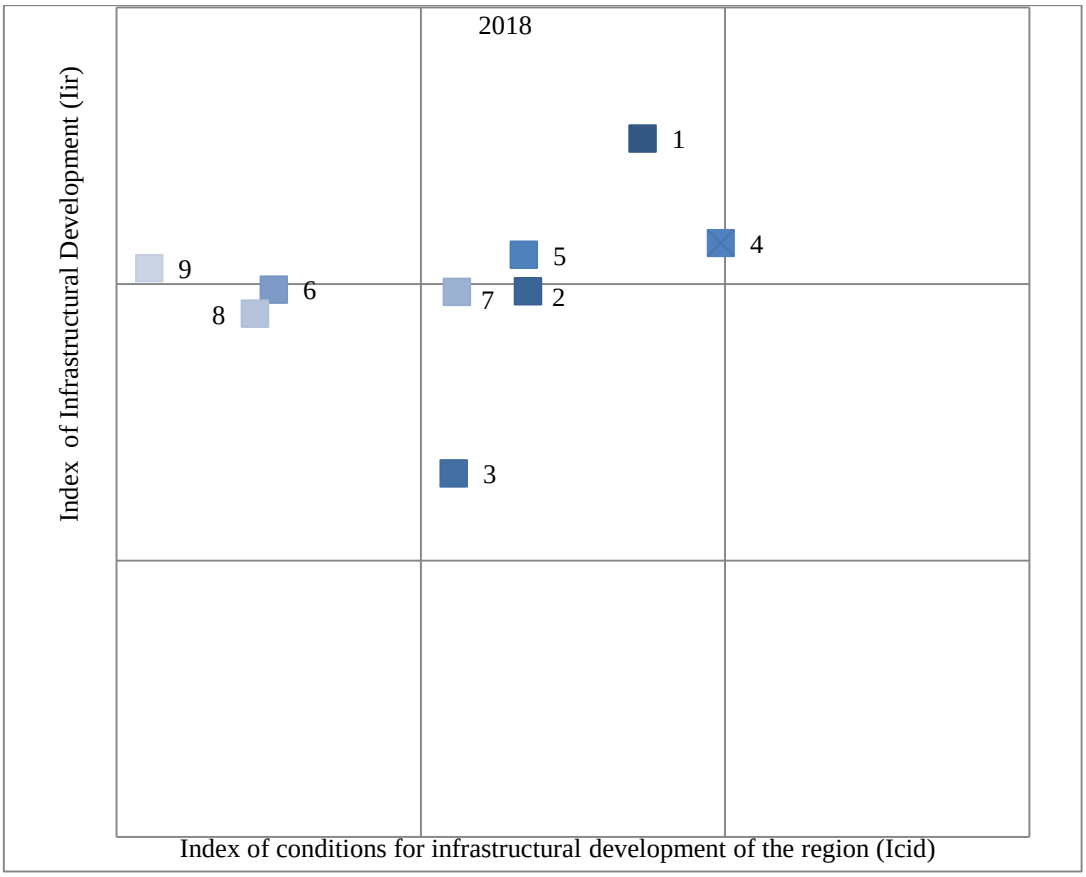
The Republic of Komi, the Krasnoyarsk region, and the Nenets Autonomous Okrug are classified as balanced regions. This means that these regions have a level of infrastructural development corresponding to the conditions, so they are developing steadily.

The Yamalo-Nenets Autonomous Okrug and the Republic of Sakha (Yakutia) are assigned to the group of "actively developing regions". In general, the regions of this group also deserve positive assessments since, in the absence of any favorable conditions, they were able to achieve an average level of infrastructural development.

The group of "advanced regions" did not include any of the studied regions. However, it is worth noting that the Arkhangelsk region has borderline significance and seeks to fully realize the existing infrastructural potential of the region, while at the same time providing higher conditions for its development. It should also be noted that in the "advanced regions" group, the Republic of Karelia has the highest level of infrastructural potential development, higher than the Arkhangelsk and Murmansk regions, but the conditions for its development are lower than in the Arkhangelsk region.

The groups "problematic regions" and "passive regions" also did not include any of the Arctic regions of Russia. This means that the Arctic macroregion as a whole is characterized by the identity of infrastructural development, its components, and the existing conditions for the development of this potential.

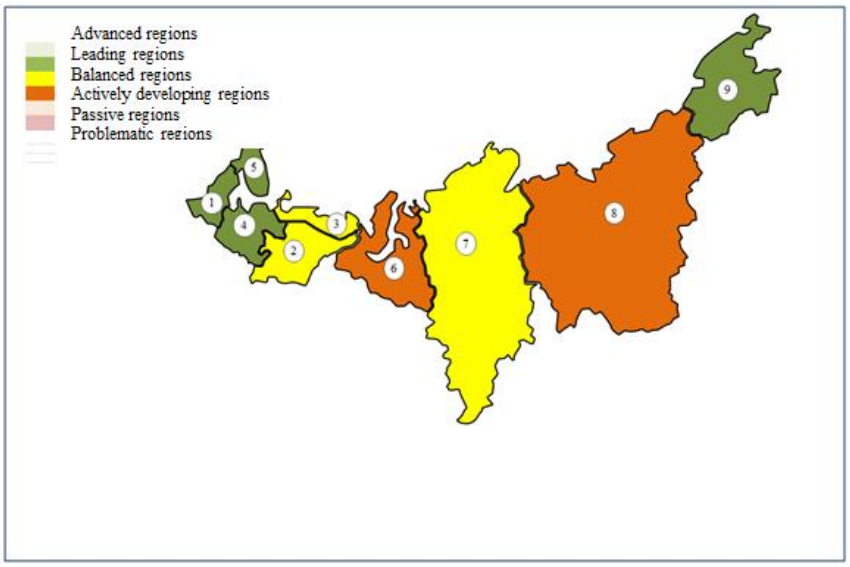
Figure 3 illustrates the results of the study.



1. Republic of Karelia
2. Komi Republic
3. Nenets Autonomous Okrug
4. Arkhangelsk region
5. Murmansk region
6. Yamal-Nenets Autonomous Okrug
7. Krasnoyarsk region
8. The Republic of Sakha (Yakutia)
9. Chukotka Autonomous Okrug

Fig. 3. Matrix — the infrastructural potential of the Arctic regions of Russia for 2018.

Source: Compiled by the authors based on the calculations



1. Republic of Karelia
2. Komi Republic
3. Nenets Autonomous Okrug
4. Arhangelsk region
5. Murmansk region
6. Yamal-Nenets Autonomous Okrug
7. Krasnoyarsk region
8. The Republic of Sakha (Yakutia)
9. Chukotka Autonomous Okrug

Fig. 4. Map of the infrastructural potential of the Arctic regions of Russia, 2018.

Compiled in accordance with Figures 2 and 3, 2018

Conclusions

We have proved the relevance of the problems of the development of territorial infrastructure on the example of the Russian Arctic regions and the need to develop a new methodology for assessing the infrastructural potential of the territory.

In the course of the analysis of the regions of Russia that have land territories of the Arctic zone, it was revealed that the studied regions are highly differentiated by the value of their infrastructure potential. This is due not only to the existing economic and political conditions, but also to the historical, sociocultural, climatic and spatial-territorial features of each studied region. According to the authors, when developing complex strategic documents in the field of infrastructural development of the Arctic regions, these features should be taken into account and an individual approach to the development of the territory of each specific region should be applied.

The proposed assessment methodology makes it possible to develop recommendations for constituent entities of the Russian Federation, both in terms of increasing the level of infrastructural potential of territories and in creating more favorable conditions for its development; for example, to increase population density or in the development of science and technology and others.

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