

Transport infrastructure development issues affecting the socio-economic situation in Arctic

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Abstract. The object of the research in this article is the transport infrastructure of the regions that are part of the Arctic zone of the Russian Federation. The authors aim to study the main socioeconomic problems that exist in the region due to the underdevelopment of transport infrastructure, as well as ways to solve them. To fulfil their research objectives, the authors used a comparative analysis method, a correlation analysis method, and a legal analysis. The study identified the specifics of the construction of transport infrastructure in the far north regions. The length of the road and rail network in the Arctic has been analysed compared with the regions of Central Russia, and the factors that limit the development of transport infrastructure have been identified. The strong dependence of freight traffic volumes on population size was revealed using the example of the Murmansk Oblast, and the main problems affecting the demographic situation in the region were identified. The problem of low passenger flow in air transportation was considered. The authors suggested the following ways of solving the problems: increasing the number of contracts PPP in their classic form, reducing the number of concession agreements, creating a transport system project based on the example of the US Interstate Highway System in the Russian Arctic, drafting a unified transport budget for all territories that make up the Arctic zone, creating a single executive authority for the Arctic zone to distribute the budget evenly. **Keywords.** transport infrastructure, public-private partnership, municipal-private partnership, concession.

1 Introduction

One of the most important factors affecting the socio-economic development of regions is transport infrastructure. It contributes to the development of production, social and housing, and communal infrastructure, which helps to maintain the sustainable development of the region's economy as a whole, as well as increasing its investment attractiveness.

Transport infrastructure guarantees the necessary conditions for the functioning of all types of economic activity in the region, as well as contributes to increasing economic potential. The transport infrastructure as a part of the market integrates distribution, circulation, production, and consumption into a single chain, thereby ensuring an accelerated circulation of material, financial and information flows in the regional economy [1].

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The transport infrastructure is understood as a real transport network used for transportation, in the form of several nodes and arcs that connect them, and each of the elements has its own characteristics [2].

For regions that are part of the Arctic zone of the Russian Federation, the issue of transport infrastructure development is particularly acute. One of the key activities in the Russian economy is the extraction of minerals for further export (10). The Arctic zone contains most of the strategic reserves of natural resources, making it one of the key areas of socio-economic development. This is especially true for the development of transport infrastructure in the Arctic regions, where there is a significant lag in development compared to other regions of the country. The close study of this problem is an important component of the socio-economic development of the Arctic and of the national security of the Russian Federation.

To date, it is possible to identify four main types of transport involved in cargo and passenger turnover in the Russian Federation. These include:

- road transport;
- rail transport;
- military and civil aviation;
- the sea and river fleet.

In writing this paper, we have studied the work of academics such as Gimpelson V.E., Kuzmenko S.Y., Zemkov V.V., Borschevsky G.A. [5-7, 9].

2 Materials and Methods

According to Rosstat, in the Russian Federation in 2021, the total length of roads was 1 566 145.1 km, while railways accounted for 86 987.4 km. Annual road freight turnover is 104 592 891.8 thousand tonne-kilometres. The length of roads in the Nenets autonomous district is only 404.5 km, and the volume of road freight transport is 21 192 000 tonne-kilometres. In Murmansk Region, there are 3 662.4 km of public roads, 870.3 km of railways and 91 993 thousand tonne-kilometres of road freight transport. The length of roads in Yamal-Nenets autonomous district is 2 986.2 km and 480.9 km of railways, freight transport is 411 696 thousand tonne-kilometres. As for Chukotka Autonomous District, it has 2 243.9 km of roads, no railway connection, the same as Nenets Autonomous District, and 4 453 thousand tonne-kilometres of goods transported by road.

Tver and Voronezh oblasts can be compared by way of comparison. The Tver Region has a total length of public roads of 35 823.9 km, a railway network of 1 806.8 km, and road transport freight traffic of 840 624 thousand tonnes-km. Roads in Voronezh region comprise 30 673.5 km, with a volume of 2 443 841 thou. tons-km and railways 1 194.3 km. The data is shown in Table 1.

Table 1. Length and turnover of roads and railways.

Name of region	Length of roads (km)	Length of railway tracks (km)	Cargo turnover (thousand tonne-km)
Murmansk region	3 662.4	870.3	91 993
Yamalo-Nenets Autonomous Okrug	2 986.2	480.9	411 696
Nenets Autonomous Okrug	404.5	-	21 192
Chukotka Autonomous District	2 243.9	-	4 453
Tver region	35 823.9	1 806.8	840 624
Voronezh region	30 673.5	1 194.3	2 443 841

From the above data, we can conclude that in terms of transport infrastructure development, the regions of the Arctic zone lag significantly behind even the less economically developed regions of central Russia, let alone regions such as Moscow or St. Petersburg. Given the critical economic importance of the regions of the far north, such low indicators significantly hamper the development of the entire national economy of the state.

Another problem of the Arctic zone, affecting the development of transport infrastructure, is the annual decrease in the volume of road freight transport, especially in the Murmansk Oblast. The authors have carried out a correlation analysis to establish the relationship between the decline in freight transport and the natural population decline. There is also limited competition in the rail freight market, a problem that exists not only in the Arctic zone, but also throughout the Russian Federation. [8].

Table 2. Rosstat data on population and freight volumes from 2012 to 2021.

Year	x (population size)	y (freight volume million tonnes)	\bar{x}	\bar{y}
2021	732864	1.9	760758.1	3.08
2020	741404	2.0		
2019	748056	2.0		
2018	753557	2.2		
2017	757600	3.5		
2016	762200	3.3		
2015	766300	3.5		
2014	771100	3.8		
2013	780400	4.5		
2012	794100	4.2		

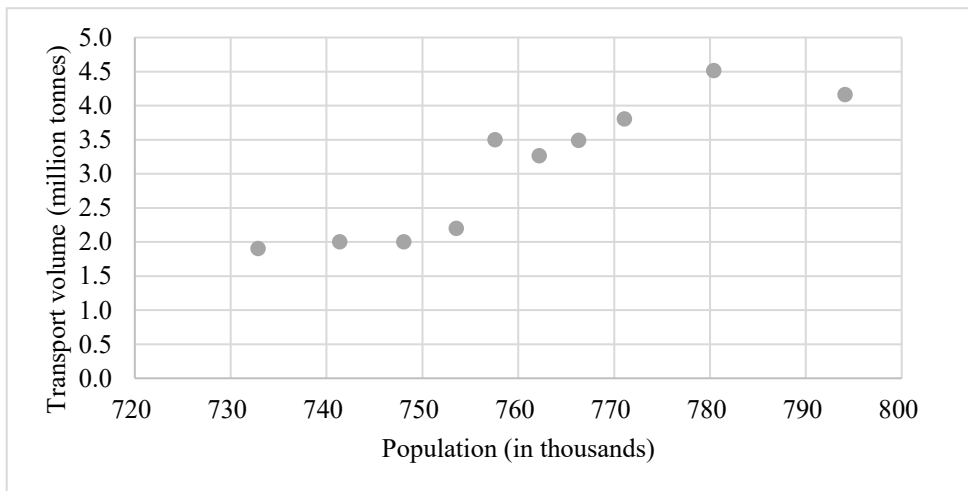


Fig. 1. Dependence of the volume of freight traffic on the population of the Murmansk Oblast.

Correlation analysis was done using Pearson's formula:

$$R = \frac{\sum(x - \bar{x})(y - \bar{y})}{\sqrt{\sum(x - \bar{x})^2 \sum(y - \bar{y})^2}}$$

Where:

R – correlation coefficient;

x – factor value (population size);

y – value of the result, which depends on a factor (volume of freight);

\bar{x} – arithmetic mean of the factor;

\bar{y} – arithmetic mean of the results.

By calculating the correlation coefficient using this formula, we obtain $R = 0.91$, which indicates a strong direct correlation between the volume of freight traffic and the population of the Murmansk region.

Among the main reasons for the outflow of population from the Murmansk region are:

1. Harsh natural and climatic conditions.
2. Poor environmental situation in large settlements due to high concentration of harmful industries.
3. High percentage of dilapidated and dilapidated housing.
4. Virtually no housing construction.
5. Little choice of educational institutions for the younger generation.
6. High unemployment rate.

The latter problem should be discussed in more detail. According to Rosstat, the average unemployment rate in the Russian Federation in 2021 was 4.8%, but only 3.9% in the Northwest Federal District, while in the Murmansk region the figure is 5.9%. In the Nenets Autonomous Okrug, the unemployment rate is already 7%. One should also note that the trend is reversed in the Yamalo-Nenets Autonomous Area and Chukotka, where the unemployment rate is only 2.1% and 2.6%, respectively.

This difference is primarily due to the large number of large oil and gas companies located in the Yamal-Nenets and Chukotka Autonomous Okrugs.

The situation is completely different with maritime communication in the Arctic zone. Today, one of the largest ports in the Russian Federation operates in the Arctic. These are the port of Murmansk and the port of Arkhangelsk.

One of the main arteries of the world economy, the Northern Sea Route, passes through these ports. It serves all major Arctic ports and major Siberian rivers. It is the shortest route connecting Europe and Asian countries.

According to the statistical data presented by the Federal Agency of Sea and River Transport, the volume of traffic along the Northern Sea Route in 2021 alone was 34 867.9 thousand tons, and every year this figure is only growing. This indicates that the Northern Sea Route is becoming increasingly popular and profitable for a large number of countries.

By comparison, the total volume of freight transported by sea in the Russian Federation from January to December 2021 was 23,439.6 thousand tonnes, assuming that half of the year the Northern Sea Route is virtually non-operational due to freezing temperatures.

The peculiarity of development of ports in Russian Arctic basin is that 98 % of the cargo turnover is in the western sector and it is concentrated in a small number of effectively operating ports: Murmansk (58 %), Sabetta (17 %), Varandey (7 %) [13].

This makes it clear that due to the increasing volume of traffic along the Northern Sea Route, the development of logistics chains and transport infrastructure in the northern regions will give a significant boost to the Russian economy in the future. The northern regions themselves will become a key transport hub [11].

The Russian economist and railway theorist Konstantin Yakovlevich Zagorsky noted in his works the great importance of transport infrastructure development and gives very significant effects "in all areas of human life - economic, social, cultural and state". They are achieved through:

- reducing the production costs of getting goods to the point of sale;
- concentration of production;
- the creation of new production areas;
- an even distribution of the workforce through labour migration;

- development of sparsely populated and hard-to-reach regions.

The construction of transport infrastructure in the Arctic zone of the Russian Federation has its own specifics (Figure 2).

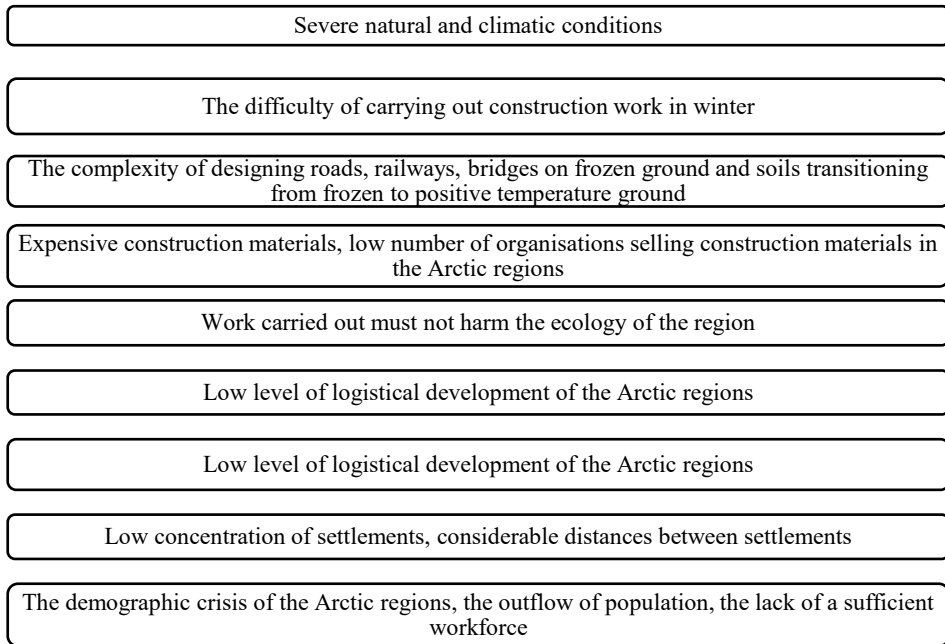


Fig. 2. Specifics of transport infrastructure construction in the Arctic zone of the Russian Federation.

Thus, the construction of transport infrastructure in the Arctic zone of the Russian Federation is a much more complex process than in the rest of Russia.

It is also worth examining the costs of transport infrastructure construction and provision in the main regions of the Arctic zone. All the same regions in Central Russia, namely the Voronezh and Tver regions, are used as a comparison. The figures in Table 3 are taken from draft regional and district budgets.

Table 3. Expenditure on transport infrastructure by the regional and district budgets of the constituent entities of the Russian Federation in 2022.

Name of region	Regional transport infrastructure expenditure (RUB thousand)
Arctic zone of the Russian Federation	
Murmansk region	3 477 325.7
Yamalo-Nenets Autonomous Okrug	5 197 263
Nenets Autonomous Okrug	860 427.5
Chukotka Autonomous Okrug	1 491 068.2
Central Federal District	
Tver region	4 775 432
Voronezh region	4 215 952.1

From the above data, we can conclude that only the expenditure on transport infrastructure development in the Yamal-Nenets Autonomous Area is comparable with the regions of the Central Federal District, but even so, the amount of funding is insufficient, as the area of the Yamal-Nenets Autonomous Area is 769 250 km², which exceeds the area of the Tver region (84 201 km²) by a factor of 9 and the area of Voronezh Oblast (52 216 km²)

by a factor of 15. Considering the specifics of transport infrastructure construction, which have been outlined above.

There is a much more serious lag in the rest of the Arctic zone of the Russian Federation, which, given its economic importance, from the Northern Sea Route to mining, significantly affects the growth rate of the country's economy; it also has implications for national security. The Arctic zone is a strategic region, including militarily, because of the rivalry for control of the Arctic shelf with Canada, Denmark, Finland, Iceland, Norway, Sweden and the United States.

The lack of a sufficient number of airports in the Arctic, which significantly limits air traffic, also requires special attention. To date, according to the Arctic Investment Portal, the number of airfields located in the Arctic zone of the Russian Federation is only 39. Of these, only 35 airfields have light-signalling systems and only 25 have artificial pavement. By comparison, there are more than 450 airports on the territory of the US Alaska. The high cost of air travel and the low purchasing power of the population also have a serious impact on air travel [12].

The fundamental document regulating the socio-economic development of the Arctic is the Presidential Decree of 26 October 2020 No. 645 "On the Strategy for Developing the Arctic Zone of the Russian Federation and Ensuring National Security for the Period to 2035". The main objectives of this strategy, which relate to the development of transport infrastructure, are:

- encouraging the participation of State corporations, companies with State participation and private investors in the construction and modernization of social, housing, utilities and transport infrastructure and in the development of infrastructure in areas traditionally inhabited by small peoples and their traditional economic activities;
- improve subsidy mechanisms for long-haul, inter-regional and local (intra-regional) air transport;
- creating a system of State support for the delivery of fuel, food and other essential goods to settlements in remote areas.

This strategy envisages the construction of new highways and railways in the Arctic regions. These include the Sosnogorsk - Indiga, Obskaya - Korotchaev and Obskaya - Sabeta railway lines, the Kolyma - Anadyr, Syktyvkar - Naryan-Mar motorways.

In addition to all of the above, there are also a number of serious problems that are not addressed by this strategy. For example, Norilsk, one of the largest centres of non-ferrous metallurgy in the Russian Federation since its foundation in 1935, still has no road or rail connections to the rest of the Russian Federation. The only connections with the "mainland" are by air and sea.

In the conditions of the far north, these means of communication cannot function all year round and uninterrupted due to the natural and climatic conditions, which causes a sharp rise in prices of essential goods, construction materials, fuel, housing and utilities, etc.

This leads to a significant brake on the socio-economic development of the city, the outflow of population, increased expenditures of federal, regional and local budgets.

The same problem is seen in much of the Arctic zone, where hundreds of settlements still remain unconnected to the outside world, leading to rapid desolation.

3 Results and Discussion

In order to meet these challenges and address the problems identified, attention should be paid to increasing the number of public-private partnership contracts. Currently, only 25 agreements have been concluded in the Russian Federation on PPP with a total investment of 59.6 billion roubles. Most of these agreements have been for the construction of educational and health care facilities.

In economic science, the concession agreement is regarded as one of the public-private partnership mechanisms

The main advantage PPP is that the main operator of the contracted facility is the state, which ensures the stable operation of the facility.

In the provision of transport infrastructure in the Arctic regions, attention should also be paid to the multiplication of the contracts concluded PPP/MPP in their classic form, as such a mechanism PPP and MPP as concession is not suitable for the construction of federal and regional public roads, which are free of charge and therefore will not be able to generate income for the concessionaire.

Given the specific nature of the Arctic zone, the cost factor cannot come first, i.e., the implementation of various projects should not be limited by its price, and the payback period of projects can take decades. This has a serious impact on potential investors who want to invest in projects. A high project price and a very long payback period discourage them, thereby reducing the flow of funds to private companies.

In order to increase the attractiveness of investment projects and the efficiency of the above mechanism, a number of tax incentives should be envisaged for private investors channeling their capital into the development of the Arctic zone of the Russian Federation. An example would be the establishment of a reduced rate of corporate income tax, which would depend on the amount of investors' monetary investment.

In the opinion of the authors, consideration should be given to the creation of a Federal Expressway Network programme along the lines of the US Interstate Highway System programme. This system was intended to link all major cities and state capitals into one unified road network (Figure 3).

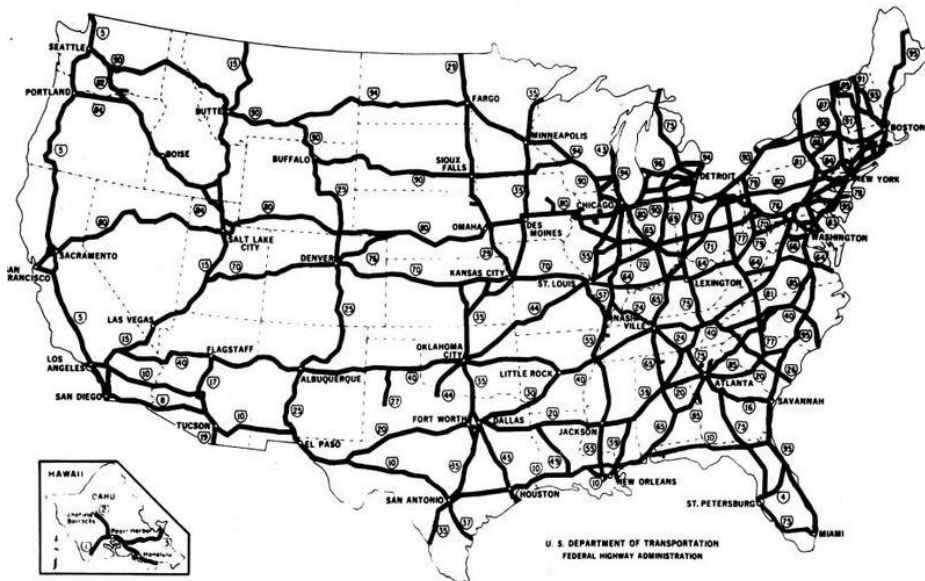


Fig. 3. Interstate Highway System.

The construction of the expressway system has increased US business activity, increased labour efficiency and investment, created new jobs and reduced the number of accidents. The increase in productivity in the USA was 25%, and the total economic benefits reached the level of \$2.1-2.5 trillion, which is 16-19 times more than the cost of building expressways [3].

Implementing a similar program in the Arctic zone of the Russian Federation would connect all major Arctic cities in a unified transport network and increase the number of links

to the rest of the Russian Federation. This would not only give a strong impetus to economic growth in the Arctic zone, but could also partly solve the demographic problem.

In order to develop air links within the Arctic zone, attention should also be given to co-financing with private companies. This would make it possible to renovate old airfields and airports, and to build new ones, using them as joint facilities. This would not only increase passenger traffic, but also create new military bases Russian VKS to increase its military presence in the regions. These airfields should be a permanent location for Russian VKS and at the same time accept civil aviation on a permanent basis, i.e. operate as an ordinary civil airport. This solution would significantly reduce the state's costs of maintaining and operating airfields, while giving a boost to air transport in the Arctic zone.

The main priority for the state could be the creation of a single executive authority that would provide financing and control over the construction or reconstruction of transport infrastructure for all the territories that make up the Arctic zone. This solution also implies the creation of a single budget for the development of the transport sector for all regions.

Regional budget expenditures allocated for the provision of transport infrastructure are transferred to the unified budget, the funds transferred from the Federal Budget are also transferred there. In its turn, the single executive body allocates certain funds for the development and implementation of various programmes.

This solution would facilitate an even distribution of budgetary funds according to the needs of the regions, taking into account the fact that revenues to the regional and district budgets vary considerably. Equally worth noting is the fact that many regions are not fully part of the Arctic zone, but only their individual municipalities. These territories are in critical need of additional funds for their projects.

4 Conclusion

The study identified the reasons for the serious socio-economic lagging of the Arctic zone compared to the rest of the Russian Federation, which include:

- 1) Low degree of development of road and rail networks.
- 2) Lack of adequate numbers of airfields and airports.
- 3) Insufficient regional funding.
- 4) Lack of adequate investment by private companies.

The consequence of these problems in the transport sector has been a serious demographic crisis, a drop in freight transport, with one of the largest sea routes passing through the Arctic, and increased unemployment due to the small number of jobs.

The authors proposed a shift from the concession mechanism to a classic Public-Private Partnership with a number of incentives for investors. Establishment and gradual implementation of a high-speed motorway programme along the lines of the US Interstate Highway System. Establishment of a single Arctic zone executive authority to control and reallocate federal and regional budgets across the Arctic, as well as the creation of a single budget.

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