Development of transport infrastructure in the regions of the Arctic zone of the Russian Federation from the position provisions of national security

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Abstract. The value of the Arctic regions, for contemporary Russia it is difficult to overestimate the enormous natural resource, geopolitical, and socio-economic potential makes them an area of strategic interests. It is in the Arctic that the main reserves of oil, natural gas, nickel, copper, diamonds, iron, tin, zinc, tungsten, coal and uranium are concentrated. The study revealed that the development of transport infrastructure in the Arctic regions is a priority direction of the implemented “National security strategy of the Russian Federation for the period up to 2020”. At the same time, the main purpose of the implementation of this paragraph of the Strategy is to increase the efficiency of industrial development of the Arctic regions, as well as the creation of favorable conditions for improving their socio-economic development. To achieve this goal, it is planned to create a single Arctic transport system, the key element of which will be the Northern sea route. The paper analyzes the state of the main types of transport represented in the regions of the Russian Arctic – road, water, air, rail and pipeline. Being in fact a kind of tool for the implementation of regional and national economic interests, the transport sector plays a key role in the development of these territories, allowing the delivery of raw materials and products to markets. The analysis of transport infrastructure of the Arctic areas showed their moral and physical obsolescence. Despite the fact that the volume of freight traffic transportation by sea in Russia is insignificant, the growth rate of traffic on the Northern sea route in 2018 is impressive.

1. Introduction

In accordance with the current “Decrees № 296 of may 2, 2014 [1] and № 287 of June 27, 2017 [2] of the President of the Russian Federation”, the Nenets Autonomous district, the Chukotka Autonomous district (AD), the Yamal-Nenets Autonomous district and the Murmansk region are fully assigned to the Arctic zone of the Russian Federation (AZRF). In addition, the Russian Arctic includes some areas of the Arkhangelsk region, the Republic of Sakha, the Republic of Karelia, the Republic of Komi and the Krasnoyarsk territory. It should be understood that the area of the Russian Arctic – 9 million square kilometers, which is home to more than 2.6 million people, that is, about 45% of the total population of the Arctic.

The importance of these territories for modern Russia it is difficult to overestimate the enormous natural resource, geopolitical, and socio-economic potential, making them an area of strategic interests. It is in the Arctic that the main reserves of oil, natural gas, nickel, copper, diamonds, iron, tin, zinc, tungsten, coal and uranium are concentrated [3]. Being in fact a kind of tool for the
implementation of regional and national economic interests, the transport sector plays a crucial role in
the development of the Arctic regions, allowing the delivery of raw materials and products to markets.
In the structure of the employed population, according to Rosstat—the Federal state statistics service,
more than 8.5% of the population of Russia's main place of work associated with the transportation of
passengers or cargo delivery [4].

2. Problems of transport infrastructure development in the AZRF
The key direction of the development strategy of the AZRF is the development of traffic infrastructure
in the Arctic areas [5]. The primary goal of this direction is to increase the efficiency of industrial
development of the Arctic regions, as well as the creation of favorable conditions for improving their
socio-economic development. To achieve this goal, it is planned to create a unified Arctic transport
system, the main elements of which will be:
- The Northern sea route (NSR) – the transport communication of national scale, which runs along the
  seas of the Arctic and partially Pacific ocean. In fact, this is the shortest route connecting the far East
  and the European part of the Russian Federation;
- ports and means of hydrometeorological, navigational and hydrographic support – the so-called
  coastal infrastructure that allows transport support in the difficult climatic conditions of the Arctic;
- vehicles, including road, rail and pipeline transport, as well as aviation and river and sea fleet.

2.1. Northern sea route
The central place in the formed Arctic transport system is given to the Northern sea route (NSR). In
generally, the NSR is considered as an alternative to the Suez canal, because it has a number of
advantages:
- first, it is a shorter distance that ships have to travel to transport raw materials and final products. For
  example, the way from Yokohama – the largest Japanese port to the port of Murmansk, through the
  Suez canal, will be almost 12850 nautical miles, and on the Northern sea route – 5800 nautical miles,
  that is 2.2 times less. In the case of the Northern route, corporations have the opportunity not only to
  reduce transport costs, but also to save time [6];
- secondly, it is the absence of pirates on the route. Despite the fact that the peak of piracy in the
  Indian ocean fell on 2010-2012, shipowners are still forced to bear the additional costs for the
  maintenance of security fleets. In Northern latitudes, problems with pirates there is no, moreover, here
  there is no restrictions on tonnage and size prosperously courts.

Nevertheless, it should be noted that the route through the Suez canal has an important advantage –
favorable climatic conditions that contribute to the implementation of maritime transport. Navigation
on the Northern sea route is seriously hampered by strong winds, the length of the polar night and the
presence of ice sheets.

It is also worth noting that to improve the efficiency of the use of the NSR route, a number of
problems should be solved:
- first, to make more transparent the procedure for the formation of tariffs for the wiring of ships
  along the Northern sea route. The tariffs applied for vessels ' routing along an alternative route through
  the Suez canal are several times lower than those applied on the NSR route [7];
- secondly, compliance with international shipping regulations, considerable modernization require
  the ports located along the Northern sea route – Tiksi, Pevek, and Dikson, Dudinka, Khatanga. To
  significantly increase the volume of traffic in the shortest period of time necessary to complete the
  construction of a new port Indiga and Varandey;
- the expansion of the icebreaker fleet is another important element of the project to create a unified
  Arctic transport system. Without modern universal and dual-purpose icebreakers it will be impossible
to carry out the wiring of ships on the route of the NSR.

Data from weather stations located on the coast and islands of the Arctic ocean, show that over the
past hundred years, the temperature in the Arctic has almost constantly increased. The average
temperature increase on the Northern sea route reached the level of 2 - 4°C [7], as a result, in the
summer, there was a significant decrease in the thickness and area of ice. This led to the fact that in 2018, for the first time, without an icebreaker escort, two gas tankers - “Eduard Toll” and “Vladimir Rusanov”, within the framework of the “Yamal – LNG” project, passed along the eastern itinerary in the direction of the Bering strait. It is noteworthy that both tankers carried out the delivery of liquefied natural gas from the port of “Sabetta” to the Chinese port of “Jiangsu-Zhudong”, and the time of their stay in transit was 20 days. This is 15-16 days faster than the passage of ships through the Suez canal [8].

The reduction in the area and thickness of the ice cover caused by the increase in the average annual temperature in the Arctic makes the Northern sea route more attractive for the transportation of goods, in the western and eastern directions. It is worth noting that the NSR has long been considered by China, as an alternative to the Suez canal, for the supply of its products to Europe. We are talking about billions of tons of freight, at the end of 2017, the proportion of Chinese goods in total amount of imports of the European Union exceeded 17% [9].

In the summer navigation of 2012, the Chinese icebreaker "Snow Dragon" for the first time passed along the NSR to the west and back. And after 5 years, he performed the eighth Arctic expedition, as a result of which, for 83 days, he sailed around the Arctic ocean, overcoming the NSR and the Northwest passage.

Such rapid melting of ice contributes to the intensification of the struggle for Arctic resources. According to experts, the proven hydrocarbon reserves on land are significantly inferior to those located on the so-called shelf, and the reduction in the thickness and area of the ice cover significantly increase both the probability of their production and the safety of extraction [10]. The latest technological advances in the field of offshore drilling, as well as the melting of ice, make the Russian Arctic extremely attractive for development. It should be recognized that all work on the organization of production and transportation of hydrocarbons to end users is impossible without the full functioning of the Northern sea route. According to experts, it is the export transportation of liquefied natural gas and oil that will become the basis of the cargo flow of the NSR [10].

The data presented in figure 1 confirm that, between 2015 and 2018 years, the volume of freight traffic transported along the NSR has increased significantly. Moreover, at the end of 2018, the volume of cargo transportation reached the level of 19,689 million tons, which is 84% more than at the end of 2017 [4]. Such dynamics is explained by the implementation of the “Yamal-LNG” project, which provides for the production and movement of about 16.5 million tons of LNG per year. It is also worth noting the company PJSC "MMC Norilsk Nickel", which share, according to the results of 2017, accounted for a significant part of the goods transported on track NSR.

![Freight volumes on the Northern sea route, millions of tons](image-url)

Figure 1. Freight volumes on the Northern sea route, millions of tons [4]
Despite such a significant growth amount of freight traffic on the track of the NSR, in generally, the share of maritime transport in the total volume of cargo turnover is extremely small – about 1%. Table 1 presents data on the volume of goods transported by different modes of transport.

Table 1. Dynamics of the volume of cargo transportation by different modes of transport [4]

| Mode of transport | 2005  | 2010  | 2016  | 2017  | 2018  | Share of certain types of transport in the total volume of cargo turnover, % |
|-------------------|-------|-------|-------|-------|-------|-----------------------------------------------------------------------------|
|       | (billion tons-km) | (billion tons-km) | (billion tons-km) | (billion tons-km) |     |                                                                             |
| Automobile       | 153   | 211   | 234,5 | 250,9 | 259,0 | 4.59                                                                        |
| Aerial           | 2.9   | 3.9   | 6.5   | 7.6   | 7.8   | 0.14                                                                        |
| Internal water   | 72    | 98    | 64.8  | 64.5  | 62.6  | 1.11                                                                        |
| Railway          | 1374  | 2094  | 2342.6| 2493.0| 2597.3| 46.06                                                                       |
| Sea              | 83    | 86    | 42.7  | 45.9  | 44.9  | 0.80                                                                        |
| Pipeline         | 1919  | 2468  | 2489.2| 2614.9| 2667.8| 47.30                                                                       |

2.2. River transport

Despite the fact that the share of river transport accounts for only 1.11% of the total volume of cargo turnover in the country, its importance in providing the population living in the harsh climatic conditions of the Arctic, essential goods of first necessities difficult to overestimate. The meridional location of Siberian rivers, the length of the main ones – Yenisei, Irtysh, Lena, Ob, exceeds the length of roads by more than 10 times, and 4 times the length of Railways allows to connect the NSR and the Transsiberian railway. And access to the most remote points is provided by an extensive system of river tributaries [11, 12].

In Soviet times, the main advantage of this mode of transport was the low cost of transportation and a minor impact on the environment. With the collapse of the country, due to the lack of sufficient funding, the necessary attention was not paid to the development and maintenance of the waterway infrastructure. As a result, this led to:

- difficulty in determining the location of ships, due to serious disruptions in the work of radar beacons-defendants;
- significant wear of hydraulic structures and ferry crossings, which significantly complicates navigation, complicates the scheme of delivery of goods and leads to significant losses of the capacity of the coastal economy and the carrying capacity of the river fleet;
- restriction in operation in estuarine ports;
- ship owners are forced to carry out unloading to pass through the narrowness, underload ships, due to insufficient depths on certain routes [11].

2.3. Road and rail transport

Severe natural and climatic conditions – long winter, low temperatures, strong marshland in summer and permafrost - are the main problems of the development of rail and road transport in these regions. Also, the construction and operation of roads and Railways are significantly complicated by the extremely low population density and the focal nature of the development of these territories. Official statistics confirm these statements (tables 2 and 3).
From the presented data in the table shows that for these regions are characterized by extremely low density of roads with a firm covering. For example, on the national average, the density of paved roads exceeds the mark of 68 km per 100 square kilometers, and in the regions of the Russian Arctic ranges from 1.2 to 48 km. It should be understood that in some areas – Nenets, Chukchi, Yamal-Nenets Autonomous districts and the Republic of Sakha is widely practiced the use of roads of low categories, the so-called "winter roads". "Winter roads", as a rule, are called roads that can be used only in the winter season, they do not require capital investments, while cars move on frozen ground. In some areas, such roads are used for six months or more.

### Table 2. The length of highways with hard surface, thousand km. [4]

| Region                  | 2014  | 2015  | 2016  | 2017  | Density of paved roads per 1000 km² |
|-------------------------|-------|-------|-------|-------|-----------------------------------|
| Arkhangelsk region      | 12.29 | 12.39 | 12.33 | 12.19 | 21                                |
| Murmansk region         | 3.29  | 3.31  | 3.31  | 3.39  | 23                                |
| Krasnoyarsk region      | 27.0  | 27.5  | 26.9  | 27.5  | 12                                |
| Nenets AD               | 0.22  | 0.22  | 0.22  | 0.25  | 1.4                               |
| Yamalo-Nenets AD        | 2.18  | 2.22  | 2.21  | 2.32  | 3.0                               |
| Chukotka AD             | 0.64  | 0.67  | 0.69  | 0.85  | 1.2                               |
| The Republic of Sakha   | 11.37 | 11.71 | 11.71 | 11.89 | 3.9                               |
| Republic of Karelia     | 8.47  | 8.51  | 8.61  | 8.62  | 48                                |
| Republic of Komi        | 6.40  | 6.46  | 6.47  | 6.48  | 16                                |
| Russian Federation      | 1106  | 1154  | 1162  | 1171  | 68.4                              |

### Table 3. The operational length of Railways, thousand km. [4]

| Region                  | 2014   | 2015   | 2016  | 2017  | The density of the railway ways, km of ways on 10000 km² of territory |
|-------------------------|--------|--------|-------|-------|------------------------------------------------------------------------|
| Arkhangelsk region      | 1.767  | 1.767  | 1.767 | 1.767 | 30                                                                     |
| Murmansk region         | 0.8703 | 0.8703 | 0.8703| 0.8703| 60                                                                     |
| Krasnoyarsk region      | 2.067  | 2.067  | 2.067 | 2.067 | 9                                                                     |
| Nenets AD               | -      | -      | -     | -     | -                                                                      |
| Yamalo-Nenets AD        | 0.877  | 0.877  | 0.877 | 0.877 | 6                                                                     |
| Chukotka AD             | -      | -      | -     | -     | -                                                                      |
| The Republic of Sakha   | 0.525  | 0.525  | 0.525 | 0.525 | 2                                                                     |
| Republic of Karelia     | 2.226  | 2.226  | 2.226 | 2.226 | 123                                                                   |
| Republic of Komi        | 1.690  | 1.690  | 1.690 | 1.690 | 41                                                                     |
| Russian Federation      | 86     | 86     | 86    | 87    | 50                                                                     |

2.4. **Pipeline transport**

The so-called pipeline transport remains the leader in the total volume of cargo turnover in Russia for many years. Thus, at the end of 2018, it accounted for more than 2667 billion ton-kilometers, and this is 2% more than at the end of 2017. If we take the entire volume of cargo, the share of pipeline transport is more than 47.3% [4]. The main production of arctic natural gas and oil falls on the Nenets and Yamal-Nenets autonomous districts, and transportation is carried out using the pipeline system. The main advantages of this type of transport include:

- relatively low cost of transportation, as the major costs of the business are carry at the initial stage, when the construction of pipelines;
- the continuity of the process of pumping raw materials and the safety of its quality;
- the possibility of universal laying of pipes. This is especially valuable when it comes to laying pipes in the difficult climatic conditions of the Arctic.

This type of cargo transportation is also appreciated by the residents of European countries, since the supply of almost all Russian gas is carried out with the help of a system of gas pipelines. In recent years, the main consumers of Russian gas are Germany, France, the UK and a number of other European Union countries. The so-called Northern corridor has been created specifically for the transportation of Arctic gas, and the Yamal-Europe project itself is a priority for the EU countries. It should be noted that the length of the gas pipeline exceeds 3 thousand kilometers, while it comes through the territory of several countries.

The Northern corridor is intended for natural gas supplies to the European Union countries and includes several gas pipelines - "Bovanenkovo – Ukhta 1 and 2", "Ukhta – Torzhok 1 and 2", "Gryazovets – Ust-Luga", "Gryazovets – Vyborg", "Nord stream 1" and "Nord stream 2". All of these pipelines are part of the overall gas supply system (UGSS). It is worth noting that this is the world's largest gas pipeline system. The complex consists not only of facilities designed for storage and transportation of gas, but also includes implement facilities that allow for its processing and distribution. The operator of this system is PJSC Gazprom, which uses it to supply gas from the production site to the final consumers [13]. It should be noted that by the end of 2018, PJSC Gazprom delivered to the EU more than 165 billion cubic meters of natural gas.

2.5. Air transport

After the collapse of the USSR, part of the country's population lost the opportunity to use air transport services due to a significant increase in the cost of air tickets, as well as a decrease in income. As a result, the intensity of flights of local airlines fell almost fifty times, while the total number of airfields decreased from 2800 to 200 [14].

It is important to understand that small aircraft subsidized worldwide, and it is because of the lack of funding for its development in Russia looks unpromising. At the same time, the most affected are the Arctic regions, where small aircraft is often the only means of ensuring year-round availability.

For a long time, small aircraft existed at the expense of the company "Aeroflot", but with the collapse of the USSR financial assistance stopped. It was only through regional support that it could be maintained in the form in which it is now presented. Now there are 90 airfields and about 200 landing sites, although most of them are not adapted for sending and receiving small aircraft. At the same time, according to Robert Tilles – director of the center for light aviation: "Small aircraft is indispensable, and sometimes no alternative in hard-to-reach regions, and is almost not needed in Metropolitan areas and the center of the country, where a well-developed road and rail facilities" [15].

In order to implement the strategy and realization the transport support of the Arctic regions, a professional aviation union was created – Association of regional and small aviation "Aviasouz". Also, separate federal programs have been developed and are being implemented, involving compensation of costs when buying aircraft for small aircraft, support of the activities of Arctic airports, the creation of Federal state-owned enterprises (FCP). The creation of the PSF allows to unite airfields and landing sites in the regions of the Russian Arctic, thereby artificially reducing fees and restraining the growth of ticket prices. Currently, 7 state-owned enterprises have been established, of which 4 operate in the Arctic, including twenty-seven landing sites and the same number of airfields [14].

In addition, regional programs aimed at the development and maintenance of small aircraft continues to be implemented. For example, in the Republic of Sakha, local airlines are subsidized at the expense of the budget; as a result, the weighted average tariff for flights is about 30% of the economically justified. And in the Yamal-Nenets autonomous district, the program "Development of local airports" is being implemented, according to which the runway is being reconstructed and new aircraft are being purchased for the needs of small aircraft.

3. Conclusions

Thus, it can be concluded that:
1. For the Arctic regions that have a raw material economy, transport infrastructure is a kind of mechanism for the implementation of their own and national economic interests, allowing the delivery of goods and raw materials to the places of sale. Nevertheless, the analysis of the state of the transport sector showed that the communications used, for the most part, are morally and physically obsolete.

2. A key element of the unified Arctic transport system is the Northern sea route, which is essential for ensuring national security and strengthening Russia's presence in the Arctic.

3. Despite the fact that the volume of freight traffic transportation by sea in Russia is insignificant - about 1%, the growth rate of traffic on the Northern sea route – 42.7% in 2017 and 84% in 2018, is impressive.

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