The Northern Sea Route: Is There Any Chance to Become the International Transport Corridor?

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Abstract. The paper analyzes the potential of the Northern Sea Route as the international transport corridor. The Northern Sea Route is the shortest waterway between Northern Europe and Southeast Asia. The role of maritime transportation in international trade has been analyzed. The dynamics of changes in the global volume of service export involving maritime transportation demonstrates a positive trend. Based on the analysis of the characteristics of international transport corridors and requirements of participants of international goods distribution applicable to them, the necessary terms and conditions that the international transport corridor must comply with have been formulated. They include: a long-distance international transportation line; types of transport that meet the requirements of international standards; availability of technical means of transport, information, and maintenance service, international legal instruments of transportation. The conclusion on the potential compliance of the Northern Sea Route with the requirements of the international transport corridor is based on the following: The Northern Sea Route meets the requirements of a long-distance transportation line; it is connected with railway transport systems and this connection is being developed; an icebreaking fleet and port infrastructure are being developed; technical means to ensure security are being created and modernized…

1. Introduction

International transport routes play a significant role in international trade while distributing goods between Northern Europe and Southeast Asia. The Southern Sea Route through the Suez Canal is mostly used. There are alternative international transport routes across the Arctic Ocean. There is also a route from Northern Europe to Southeast Asia around Africa. There is a way through the Panama Canal, and the Nicaraguan Canal as an alternative to the Panama Canal. For a better understanding of the flow of goods from Europe to Asia, you can add to sea routes the Trans-Siberian Railway line located in Russia. The Trans-Siberian Railway is the world’s longest railway line; it is fully electrified and its length is about 9300 kilometers. [1].

In the years to come, it is possible to lay two major international transport corridors through the Arctic Ocean: the Northern Sea Route along the coast of the Russian Federation and the Northwest Passage along the coast of Canada. The Northern Sea Route is the shortest water route between Northern Europe and Southeast Asia. One of the problems of the Northern Sea Route is that approximately 4.2 thousand nautical miles of the sea route are covered with ice. In order to pass this distance, icebreakers are required. It is appropriate to compare the two options for following the route Rotterdam-Yokohama. The first option, when passing through the Suez Canal and the Indian Ocean, covers the length of 11.2
The second option implies going along the Northern Sea Route, then the length is 3.9 thousand miles shorter. Duration of the journey is reduced by a couple of weeks and tons of fuel are saved. The Russian Federation sets the rules for navigation on this route, according to the 1982 UN Convention on the Law of the Sea. According to the Federal Law of the Russian Federation, the Northern Sea Route is defined as “the historic national transportation line of the Russian Federation in the Arctic zone”.

At present, vessels are allowed to move along the route under the following conditions: vessels must be certified for ice resistance; convoys of vessels must be escorted by a nuclear-powered icebreaker; compliance with the rules established by the law of the Russian Federation. The Northern Sea Route is one of the longest and significant marine transport routes in the Russian Federation. A number of researches focuses on international marine transport routes. They include articles and monographs of the following Russian authors: Lukin Y.F., Selin V.S., Fedoseyev S.V., Zuckerman V.A., Cherepovitsyn A.E., Kozmenko S.Y., Kondratov N.A., Ponomarev N.N., Pavlov K.V., and others. The above-mentioned authors consider theoretical approaches to organizing international transport corridors and analyze specific examples.

Considering the Northern Sea Route, they focus on the administrative and economic issues of the revival and development of the Northern Sea Route, determine the necessity for radical restructuring of activities. They draw a conclusion that it is necessary to turn the Northern Sea Route into an efficiently operating waterway for the development of the Arctic zone. The development of the Northern Sea Route will give an impetus to developing and enhancing international cooperation in the Arctic zone. The authors’ researches provide arguments to revive the Northern Sea Route and turn it into an international transport corridor. In addition, the authors describe the use of the Northern Sea Route as an international transit route to ensure export and import cargo flows in the Russian Federation, and an international extreme tourist route. Lukin Y.F. outlines some perspectives for the development of the Russian Arctic within the world globalization.

Foreign sources quite often consider the issues related to the Northern Sea Route. Duyzings T. [3] describes the current status of the Northern Sea Route and possible benefits from the use of this transport corridor, taking into account emerging natural and economic factors. Stelpa I. [4] outlines the prospects to turn the Northern Sea Route into an international transport corridor and assesses the benefits of this change.

Smith L.C., Stephenson S.R. [5], Didenko N. I. and Kulik S. V. [6] discuss various opportunities for usage of transport routes in the maritime Arctic, considering climate change and economic changes taking place in the world.

Eger M. [7], Didenko N, Skripnuk D. and Mirolyubova O. [8] compare the economics of using transport routes in the maritime Arctic taking into consideration climate change.

Taranukha N.A. [9] proves that the Northern Sea Route is intended for container shipping between Europe and Asia. He writes that it is necessary to carry out modernization and implement the development of transportation technologies along the Northern Sea Route. Kuptsov N. [10] in his paper formulates the potential and prospects of the route.

Duyzings T. [11], Hong S. [12], Didenko N. I. and Cherenkov V. I. [13], [14] research into the legal elements of the Northern Sea Route and the legal space in which the activities of interested agents are carried out. Shadian J. M. [15]. Rowe E.W. [16] underline that interest in Arctic politics is growing. And if preceding articles devoted to this topic have focused on climate change, now various issues of region geopolitics prevail.

Discussing the prospects and development trends of the Northern Sea Route is not a new goal; the Northern Sea Route is of great and constant interest. Considering the role of the Northern Sea Route, the purpose of this paper is to analyze the prospects for the Northern Sea Route to become an international transport corridor.

2. Methods
The methods for attaining the purposes of this study include: analysis, synthesis, classification, abstraction, formalization, analogy, modeling, idealization, deduction, and induction.

3. Results

3.1. Factors affecting the Northern Sea Route functioning

Figure 1 shows factors of the Northern Sea Route functioning.

![Factors of the NSR functioning](image)

**Figure 1.** Factors of the Northern Sea Route functioning
The factors of the Northern Sea Route functioning are compartmentalized in accordance with three directions: the total cargo carriage volume on the Northern Sea Route, the share of transit cargo transportation on the Northern Sea Route, the cargo carriage volume through the Suez Canal. The analysis of the opportunities for the Northern Sea Route to become an international transport corridor has been proposed to be carried out by means of a qualitative analysis and a quantitative analysis. This paper describes the approach based on the construction of the system of econometric equations. The following variables were selected as endogenous variables: the total cargo carriage volume on the Northern Sea Route, the share of transit cargo carriage on the Northern Sea Route, the cargo carriage volume through the Suez Canal. Exogenous variables are all factors affecting the Northern Sea Route functioning.

The chosen endogenous and exogenous variables allow constructing the set of equations presented in the structural form of the model. In general terms, the set of equations is as follows:

\[
\begin{align*}
  y_{1t} &= f(y_{1t-1}, x_{1t}, x_{2t}, x_{3t}, x_{4t}, x_{5t}, x_{6t}, x_{7t}, x_{8t}, x_{9t}) \\
  y_{2t} &= f(y_{2t-1}, x_{10t}, x_{11t}, x_{12t}, x_{13t}, x_{14t}, x_{15t}, x_{16t}, x_{17t}, x_{18t}) \\
  y_{3t} &= f(y_{3t-1}, x_{19t}, x_{20t}, x_{21t}, x_{22t}, x_{23t}, x_{24t}, x_{25t}, x_{26t})
\end{align*}
\]

Below, some comments on selected endogenous and exogenous variables are provided. The total cargo carriage volume on the Northern Sea Route \(y_{1t}\) taking into account that transshipment cargo tends to increase. In 2006, the total cargo carriage volume was equal to 1956 thousand tons, and it rose to 10691 thousand tons by 2017. The share of transit cargo carriage on the Northern Sea Route \(y_{2t}\) dropped from 34.6% in 2013 to 1.8% in 2017. The volume of transit cargo carriage on the Northern Sea Route is insufficient for the Northern Sea Route to be considered as an international transport corridor. The cargo carriage volume through the Suez Canal \(y_{3t}\) rose from 691,8 million tons in 2011 to 908,5 million tons in 2017.

Changes of the ice thickness and ice coverage area in the Arctic zone \(x_{2t}\). According to Riccardo Valentini, the professor of the University of Tuscia (Italy) and the head of the Euro-Mediterranean Center on Climate Change (CMCC), “on the average, over a decade the ice thickness is reduced by 13%”. It is necessary to improve the accuracy of marine forecasts, ice conditions, and seasonal risks. The ice cover is able to form quickly in a variety of places; thus, it may take a ship’s crew unawares that in its turn reduces predictability of navigation. In addition, ice melting in the Arctic zone is associated with the formation of icebergs, and the risk of collision with them not only decreases, but also may increase. The area of the annual minimum of ice in the Arctic zone ranges from 3.4 million square kilometers (in 2012) to 4.6 million square kilometers (in 2018). The probability of shipwrecks on the ice \(x_{3t}\) is massively smaller than in waters of the World Ocean. It is guaranteed by efficient organization of navigation, continuous monitoring of each vessel movement, and timely provision of icebreaking assistance. The possibility of severe water-leaky ice damage to the hull does not exceed 2% of the number of floating vessels in the Northern Sea Route. Collisions of ships in the coastal waters of the World Ocean occur with the same level of probability. For almost half a century of work on the Northern Sea Route, the annual share of shipwrecks was equal to 0.04%. The permits for passing through the Northern Sea Route \(x_{4t}\) increased from 635 in 2013 to 792 in 2018. The number of nuclear-powered icebreakers on the Northern Sea Route \(x_{5t}\) consists four. The number of transit vessels passing through the Northern Sea Route annually \(x_{11t}\) ranges from 34 (2011) to 27 (2017). The number of vessels passing through the Suez Canal annually \(x_{20t}\) ranges from 17800 (2011) to 17750 (2017). Marine insurance premium for piracy attacks in the Gulf of Aden \(x_{22t}\). Additional costs due to piracy to 100-115 thousand dollars excluding insurance, and 220-230 thousand dollars including it. The additional insurance premium for the risk of piracy in the Gulf of Aden amounts to 110,000 US dollars. Attacks of pirates in the Gulf of Aden \(x_{26t}\). There were 42 hijacks in 2008, 46 hijacks in 2009, 47 hijacks in 2010, and 28 hijacks in 2011 respectively. In 2010, the best year for pirate business, the
number of buybacks for 47 hijacked vessels amounted to approximately 238 million US dollars. The price of Brent crude oil ranges from 98.4 US dollars per barrel in 2008 and 55.5 US dollars per barrel in 2017.

3.2. Risks of the construction and operation of transportation and logistics centers in the Arctic Zone

In the Arctic zone, there are a large number of fields, pipelines, oil transshipment terminals, in other words, transportation hubs, the construction and operation of which are associated with great risks. The Arctic zone is the largest resource reserve where almost untouched hydrocarbon and mineral resources have been preserved. In the Russian Federation Arctic zone (RFAZ), the overwhelming share of all-Russian and global oil reserves (60%) and gas reserves (from 60 to 90%) is concentrated.

According to general estimates, the cost of mineral raw materials in the Arctic subsoil of the Russian Federation exceeds 30 trillion US dollars, and two thirds of them are the cost of energy resources. However, there are a number of difficulties that all countries face, wishing to start the development of hydrocarbon resources in the region. First of all, it is a severe climate: low temperatures, a long polar night, ice, and tundra. All these factors impose serious restrictions on the operation of equipment and the staff working capacity. Poor infrastructure and sometimes its total lack make the situation worse.

Stephenson, S. R. [16] writes that the recent retreat of Arctic sea ice indicates that Russian coastal seas spanning the Northern Sea Route will become one of the first marine environments that transit to summer ice-free conditions. It is planned to increase the economic viability of the Northern Sea Route for transporting natural resources from Northern Norway to the East and from the Russian Federation to the countries of Southeast Asia. However, there is significant uncertainty regarding the short-term duration and variability of the navigation season. A quantitative assessment of duration and variability of the navigation season depending on sea ice within the next 15 years remains uncertain.

Due to the remoteness of deposits from consumers, processing plants, and storage facilities, it is necessary to lay kilometers of pipelines. All pipelines in the Arctic zone are laid above the ground so as not to violate the temperature regime of permafrost, which can cause significant damage to the entire ecosystem. D. Avango, L. Hacquebord, Y. Aalders, H. D. Haas, U. Gustafsson, F. Kruse [17] analyze the driving forces of the large-scale exploitation of natural resources in the polar regions and how to understand the relationships between these forces. New historical and archaeological research conducted during the International Polar Year (IPY) 2007-2009 on whaling, hunting, and mining in Spitsbergen (1600 to the present) show both economic and geopolitical factors that have influenced the development of these industries. However, the relation between these driving forces varies both between time periods and between participants. In most cases, economic motives served as the main justification for the use of resources and for government support for exploitation of resources, but in some cases, governments even supported unprofitable enterprises in order to maintain a foothold on Spitsbergen.

Shebonti, R. D. [18] and Rowe, E.W. [19] confirm that due to the fact that global warming and melting ice make the Arctic more accessible, the richness of hydrocarbon resources in the region provokes a global interest. Until now, despite the presence of huge unused energy and mineral resources, the Arctic zone is not considered to be a geopolitical place of utmost importance. In fact, many of the Arctic states have rejected the possibility of conflict over mining activities in the region due to the established model of the shared governance. However, as the demand for resources grows constantly and factors in the international energy market begin to affect the region, how long will the Arctic zone manage to maintain a peaceful environment?

Apart from pipelines, the Northern Sea Route plays a significant role in the transportation of hydrocarbon resources in the Russian Federation Arctic zone. For the stable supply of hydrocarbon resources, it is necessary to ensure uninterrupted loading of vessels. Oil transshipment terminals are used for it.

Figure 2 shows decomposition of the causes of the risks of the construction and operation of transportation and logistics centers to ensure transportation and logistics activities in the Arctic zone. Logistics is considered to be a key challenge. Problem statement: [20], [21], [22].
difficulties in transporting incoming material and technical resources and various equipment to site structures and facilities;

difficulties in assembling components, conducting control tests, maintenance and / or repair of equipment in the Extreme North;

difficulties in maintenance of the activities of the fleet, ships, and watercraft;

difficulties in receiving of waste, including drill cuttings, oily water, waste oils, etc. and ensuring their disposal;

difficulties in recruiting, transporting shifts and third-party specialists;

emergency situations and accidents during the construction of transportation and logistics centers in the Arctic zone;

equipment failures, depressurization of pipelines under pressure, corrosion damage, oil spills, and others.

As in the previous section, we shall describe the approach based on the construction of the system of econometric equations. In this analysis, the endogenous variables are: the total cargo carriage volume on the Northern Sea Route (yt1); the oil production volume in the Arctic zone (yt2); the number of shipwrecks due to weather conditions (yt3); the number of accidents at oil terminals directly related to problems at the loading terminals (yt4).

Exogenous variables are all factors affecting the functioning of the Northern Sea Route. The selected endogenous and exogenous variables make it possible to construct a set of equations in the structural form of the model. In general terms, the set of equations is as follows:

\[
\begin{align*}
    y^1_t &= f(y^1_{t-1}, x^1_t, x^2_t, x^3_t, x^4_t) \\
    y^2_t &= f(y^2_{t-1}, x^5_t, x^6_t) \\
    y^3_t &= f(y^3_{t-1}, x^3_t, x^7_t, x^{11}_t, x^{12}_t) \\
    y^4_t &= f(x^9_t, x^{10}_t)
\end{align*}
\]

The following exogenous variables are used: the length of the Northern Sea Route on the territory of the Russian Federation (xt1); the decrease in ice thickness in the Arctic zone (xt2); the number of navigation permits (xt3); the number of icebreakers (xt4); the number of oil loading terminals (xt5); the volume of liquid cargo (xt6); the intensity of marine transport use(xt7); the number of accidents on vessels (xt8); the length of motorways in the Arctic zone (xt9); the number of airports (xt10); the number of storm warnings annually (xt11); winter temperature rise annually (xt12).

The conducted analysis shows that the Northern Sea Route increases the cargo carriage volume every year, due to the increase in transportation of liquid cargoes. In order to provide uninterrupted operation of transportation and logistics centers, it is important to increase the number of icebreakers for an unimpeded transit of tankers to oil loading terminals. It is also necessary to develop a variety of infrastructure: airports (for uninterrupted delivery of necessary components and spare parts to oil terminals), all-year-round motorways. In the Arctic zone, mostly there is no opportunity to get from point A to point B in the warm season, since there are no crossings through numerous swamps and rivers. It is necessary to develop telecommunication infrastructure, since communication service exists only in limited places close to cell phone towers. When operating transportation and logistics centers in the Arctic zone, it is important to consider climate conditions. Frequent storms can cause damage to oil loading terminals, tankers, and personnel, and constant low temperatures wear out various mechanisms and equipment faster.
Figure 2. Decomposition of the causes of the risks of the construction and operation of transportation and logistics centers to ensure transportation and logistics activities in the Arctic zone

4. Discussion

The Northern Sea Route serves the ports of the Arctic zone and major rivers of Siberia, where fuel, equipment, food are imported, and forest and natural resources are exported. Consequently, the development of ports and infrastructure of the Northern Sea Route plays a key role for the international transport corridor.

The Northern Sea Route has the longest coastline in the world. Nineteen Russian sea ports are located on the Northern Sea Route. The modern seaport is a large transport hub that connects various types of transport: sea river, railway, road, pipeline, etc. Ports are mainly engaged in transshipment foreign trade and cabotage transportation of goods. Cabotage transportation of goods accounts for about 28% of its cargo turnover.

The ports of the marine basin can be divided into three groups. The first one includes the ports of Murmansk, Archangelsk, Vitino, and Kandalaksha with railway siding facilities connected with the country's transport infrastructure. Four of these ports handle 85.4% of the cargo passing through the marine basin. The second group includes ports serving the needs of one company. They are Varandey and Dudinka. The third group includes the remaining fourteen ports, which are located in areas where there are no land communications, and which currently provide transshipping goods to provide life-sustaining activities of the settlements and their neighborhoods. Their overall capacity is used by 5-50%, and there are no prerequisites for increasing the cargo base and the cargo turnover growth. Therefore, in order to ensure proper functioning, port icebreakers are needed. Cargo delivery to ports is carried out under the ice escort of linear icebreakers, including nuclear powered ones.

The delivery of goods to the Northern Territories, which are necessary to ensure the vital activity of the indigenous Arctic ethnic groups and the development of natural resources of the vast northern territories, passes through the Arctic ports.

In the course of time, Arctic ports can focus on the transshipment of fuel and energy resources (crude oil, petroleum products, coal, liquefied gas). Oil and gas will come to ports from the shelves of the
Northern Seas. The ports of Varandey, Harasavey and the new ports of Sabetta and Teriberka were built for their transshipment. The construction of new ports is being carried out in remote areas and it requires a lot more investments than the construction of ports in other marine basins.

All the above-mentioned highlights importance of the sea port infrastructure in the development of the Arctic maritime space. Based on the above analysis, it can be concluded that the Northern Sea Route meets the basic requirements of an international transport corridor:

1. The Northern Sea Route is a long-distance transportation line. Along the Northern Sea Route, some ports are connected with other transport systems (railway). This is an additional advantage for an international transport corridor.

2. Vessels passing through the Northern Sea Route meet international standards. Therefore, ships passing through the Northern Sea Route must satisfy the current rules of the Russian Marine Register of Shipping for vessels with the ice strengthening category of the icebreaker with the symbol denoting its class - Arc4 (LU4), Arc5 (LU5), Arc6 (LU6), and also satisfy the requirements of current international conventions and the IMO's International Code.

3. Technical means of transport are being developed: the icebreaking fleet, port infrastructure, security requirements are growing, and technical means of ensuring safety are appearing and are being modernized. Looking ahead, this may become an additional advantage for the international transport corridor.

5. Conclusion
The problem of the Northern Sea Route functioning remains one of the most relevant issues of the Arctic scientific research and in the practical activities of the Russian Federation and business sector involved in operating this traffic artery. The goal of this work is to analyze the economic and geopolitical factors of the Northern Sea Route activities under current conditions, as well as the opportunities and threats of its activities. The priority areas for increasing attractiveness of the Northern Sea Route have been chosen; thus, they include development of the infrastructure and transport system of the Arctic zone, the transportation security and usage of the shortcomings of competing routes such as the passage through the Suez Canal, in particular. The stated goals can be achieved by increasing funding for the infrastructure of the Arctic zone, increasing the number of icebreakers operating in the Northern regions, modernizing ports, improving ecological environment in the Arctic zone, and establishing more favorable tariffs in comparison with the competing routes.

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