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To cite this article: Nadezhda Filippova *et al* 2021 *IOP Conf. Ser.: Earth Environ. Sci.* **678** 012019

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Improving the reliability and safety of cargo delivery for the Arctic through the creation of transport and logistics centers for multimodal transportation management

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Abstract. For the development of the Northern regions of the Russian Federation, new opportunities are created for the application of logistics methods in all areas of activity: transport management, warehouse management, stocks, etc. Taking into account the development of the situation in the economy of the Northern regions of the Russian Federation and the strengthening of market relations, as well as world experience, it is safe to say that the search for optimal transport schemes for the transportation of goods to consumers and the distribution of freight flows in the regions will be dealt with at the first stage by freight forwarding services, and then these functions will be concentrated in special terminal and logistics centers (TLC).

1. Introduction

In recent years, state authorities have been paying attention to the development of the Arctic zone of Russia. In 2008, the document “Fundamentals of the State Policy of the Russian Federation in the Arctic for the Period up to 2020” was published, approved by the President of the Russian Federation (Decree of September 18, 2008).

This paper notes that the main direction of the development of social and economic policy in the Arctic is the expansion of the resource base of the Arctic zone of the Russian Federation. It can largely meet the needs of Russia in hydrocarbon resources, aquatic biological resources and other types of strategic raw materials.

2. The main trends in the development of the Arctic zones

According to the document, at the moment the development of the Arctic is associated with a number of restrictions and risks. Among the main limiting factors affecting the socio-economic development of the Arctic zone of the Russian Federation, the natural and climatic zones of the zone are distinguished. [1]

The main risks and threats arising from the development of the Arctic zone of Russia are:

1. Risk factors affecting the socio-economic development of the Arctic zone:
 - Extreme natural and climatic conditions, including low air temperatures, strong winds and the presence of ice cover in the Arctic seas;
 - Focal nature of industrial and economic development of territories and low population density;



- Remoteness from the main industrial centers, high resource intensity and dependence of economic activity and life support of the population on supplies from other regions of Russia of fuel, food and essential goods;
- Low stability of ecological systems that determine the biological balance and climate of the Earth, and their dependence on even insignificant anthropogenic impacts.
- 2. Social risk factors:
 - Negative demographic processes in most of the Arctic regions of the Russian Federation, outflow of labor resources (especially highly qualified ones) to the southern regions of Russia and abroad;
 - Inconsistency of social service networks with the nature and dynamics of settlement, including in education, health care, culture, physical culture and sports;
 - Critical condition of housing and communal services facilities, insufficient provision of the population with clean drinking water;
 - Lack of an effective training system, imbalance between demand and supply of labor resources in territorial and professional terms (shortage of workers and engineering professions and an overabundance of unclaimed specialists, as well as people without professional education);
 - Low quality of life of the indigenous peoples of the North, Siberia and the Far East of the Russian Federation living in the Arctic zone of the Russian Federation;
 - Lack of modern information and telecommunication infrastructure, allowing the provision of communication services to the population and business entities throughout the Arctic zone of the Russian Federation.
- 3. Risk factors in the economic sphere:
 - Lack of Russian modern technical means and technologies for prospecting, exploration and development of offshore hydrocarbon deposits in Arctic conditions;
 - High energy intensity and low efficiency of natural resource extraction;
 - Costs of northern production in the absence of effective compensation mechanisms, low labor productivity;
 - Depreciation of fixed assets, in particular transport, industrial and energy infrastructure;
 - Underdevelopment of basic transport infrastructure, its maritime and continental components;
 - Dependence on foreign funds and sources of information support for all types of activities in the Arctic;
 - Aging of the icebreaker fleet;
 - Lack of small navigation aids;
 - An imbalance in economic development between individual subarctic territories and regions, a significant gap between the leading and depressed areas in terms of development;
 - Lack of means of continuous integrated space monitoring of the Arctic territories and water areas;
 - Underdeveloped of energy system;
 - Irrational structure of power generating capacities.
- 4. Risk factors in science and technology:
 - Lack of technical means and technological capabilities for the study, development and use of Arctic spaces and resources;
 - Insufficient readiness for the transition to an innovative path of development of the Arctic zone of the Russian Federation.
- 5. Risk factors in the field of environmental protection and use of nature:
 - An increase in the technogenic and anthropogenic load on the environment with an increase in the likelihood of reaching its limit values in some areas of the Arctic Ocean adjacent to the Russian Federation, as well as in certain territories of the Arctic zone of the Russian Federation;
 - The presence of especially unfavorable zones, potential sources of radioactive contamination;

- Areas with a high level of accumulated environmental damage.

3. The methodology for the formation of a hierarchical architecture of a transport and logistics center (TLC)

The development of a full-fledged transport system and infrastructure will allow not only to overcome barriers in the use of transit potential and increase the transport accessibility of settlements, but also to largely eliminate infrastructure restrictions on the growth of mining in the Arctic zone of Russia. [2]

Decree of the Government of the Russian Federation No. 366 dated April 21, 2014 approved the state program of the Russian Federation «Socio-economic development of the Arctic zone of the Russian Federation for the period up to 2020». One of the goals of the program is to improve the organizational structure of management and ensuring the safety of navigation in the Arctic zone of the Russian Federation, including through the development of an integrated Arctic transport and technological system, which includes the development of sea and other modes of transport, as well as supporting infrastructure. All these major projects are being implemented by people living (permanently or temporarily) in this zone. The life support of these people and their family members is based on the implementation of the «northern delivery» measures, the main cargoes of which are fuel and food.

The Moscow Automobile and Road Construction State Technical University (MADI) has developed an innovative scientific and methodological approach to improving the technologies for managing the transport and technological processes of multimodal transportation of goods from the north based on the development and implementation of a single transport and logistics center (TLC) in each region. [3]

A methodology for the formation of a hierarchical architecture of a transport and logistics center (TLC) and the main algorithms of the multimodal transport system management system, implemented by TLC specialists in interaction with various subjects of the transportation process, have been developed.

Thus, the TLC should become one of the important elements of the supporting infrastructure of the transport system in the Arctic zone of the Russian Federation. [4]

Practical application of the developed methodological approach to the development and implementation of a transport and logistics center on the basis of will ensure the safety, reliability and efficiency of technological processes for the delivery of goods through optimal control and management of the transport complex in real time for all modes of transport.

The levels of the hierarchical control system of the TLC, the procedure for information interaction at various levels and the tasks they solve, taking into account the identified significant risks, are described below.

Level 1 is the fundamental level from which the construction of the system begins according to the «bottom-up» principle. This level contains all the necessary regulatory and reference information (a unified reference database for the region, including OKATO codes of settlements, railway stations, river ports, airports, paved roads), digital models of routes by mode of transport, including models of permanent routes (highways of regional and municipal importance, railways), models of temporary routes (winter roads, river routes, ferry crossings).

At this level, it becomes possible to introduce new satellite navigation technologies, as well as specialized geo-information systems that will be adapted to the technological and topological features of transport processes in the regions of Siberia and the Arctic zone of Russia. Level 1 will also provide the possibility of implementing and implementing IT analytical systems based on web technologies, mobile and satellite communication systems based on digital data transmission technologies, the possibility of introducing modern technical means and technologies of transport telematics, including special solutions for the operation of road transport in harsh natural and climatic

Level 2 is a set of TLC functions in the field of planning long-term, medium-term (determining the volume of goods, using storage warehouses) and operational operations for the delivery of goods for the current navigation (terms of delivery of goods to the end user, determining routes).

Level 3 represents the TLC telematics platform, on the basis of which a geographically distributed dispatch control system is created. It is responsible for monitoring the volume of cargo delivery to the storage warehouse and dispatching vehicles with cargo by mode of transport (road, rail, river, air), monitoring the transportation of goods in transport hubs, delivery of goods to the end consumer by road.

Level 4 describes the TLC integration platform, which includes an information and analytical system for participants in the process of delivering goods from the north: the regional administration, the Ministry of Emergency Situations, the Ministry of Internal Affairs, service 112, regional dispatch centers, cargo owners (customers), carrier enterprises (car drivers). [5]

One of the effective measures to reduce the risk and improve the safety and reliability of rolling stock operation is to monitor traffic on the route using the data of the information and navigation system.

For the first time, a methodology for assessing the parameters of the movement of vehicles on the route in the conditions of Siberia and the Arctic zone of Russia has been developed. The technique allows you to determine the distance traveled using a digital model of a given route of movement. In the navigation monitoring system, the model of the route is represented as a piecewise-broken line, the ends of the segments of which are tied to the latitude and longitude of the corresponding points on the ground. Automatic control of the actual movement in relation to the planned one is carried out continuously according to the incoming navigation data based on the use of the «distance function», which for a given moment in time determines the actual distance traveled by the controlled vehicle from the starting point of the route and compares it with the planned one, calculating the movement deviation in time (δt), which is especially important for controlling the movement of vehicles on auto winter roads.

The system technologist for each section of the route sets the maximum permissible values of δt , upon exceeding which the system automatically generates a signal to the dispatcher about the need to carry out regulatory actions in order to return the process of delivering goods by road to the planned state or, if this is not possible, in order to reduce the negative consequences of the admitted deviation.

In the process of multimodal transportation of goods in the north of Russia and its Arctic zone, extreme conditions often arise associated with a deterioration in visibility due to bad weather or when crossing the most dangerous sections of the route. In the developed methodology, an approach to organizing the automatic movement of a convoy of vehicles in especially dangerous areas is proposed. In this case, the mode of automatic control of the movement of vehicles can eliminate the risk of loss of life or health of drivers and crew members. [6]

4. Conclusion

An analysis of gigantic projects for the development of the Arctic zone of Russia shows that a safe and reliable transport infrastructure plays the main role in these projects. Its creation and efficient operation are impossible without ensuring reliable and safe operation of the nodes of this multimodal network, the role of which should be played by transport and logistics centers. A necessary element of the junction objects of railway lines standing on the great Siberian rivers and on the shores of the Arctic seas should be transport and logistics centers (TLC), which provide planning and management of the delivery of essential goods to the population of the corresponding regions. Considering the strategic importance of these facilities and the high load on the multimodal transport network, the TLC should be designed and implemented on the basis of scientific developments related to the organization, technology and hardware and software of the TLC control systems.

The solutions developed by MADI scientists concerning the organization, algorithmic and software of multimodal transport and logistics centers can serve as the basis for the design and implementation of such centers at the nodes of the transport network of the Arctic zone of Russia.

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5. References

- [1] *Fundamentals of the state policy of the Russian Federation in the Arctic for the period up to 2020 and beyond*: decree of the President of the Russian Federation of 18 September 2008 Available at: http://www.consultant.ru/document/cons_doc_LAW_119442/
- [2] Filippova N 2019 Hierarchical levels of management of the multimodal transport system for the transportation of goods from the northern delivery *Bulletin of the Moscow Automobile and Road Construction State Technical University (MADI)* vol 4
- [3] *Transport strategy of the Russian Federation for the period up to 2030*: the order of the government of the Russian Federation of 22 November, 2008 Available at: http://www.consultant.ru/document/cons_doc_LAW_82617/
- [4] Strategy for the development of the Arctic zone of the Russian Federation and ensuring national security for the period up to 2035 Available at: <http://government.ru/info/18360/>
- [5] Filippova N 2015 *Methodology for the organization and functioning of systems for the delivery of goods to the northern regions*: monograph
- [6] Filippova N 2019 Ensuring efficient and reliable delivery of northern cargoes for the regions of the Far North and the Arctic zone of Russia
- [7] Poleshkina I 2020 The influence of the development of the regional air transportation network in the North regions, Logistics is a Eurasian bridge *Materials of the XV International Scientific and Practical Conference*
- [8] Poleshkina I 2020 Application of modern technologies in the airport cargo terminal: foreign experience and russian practice, Logistics is a Eurasian bridge *Materials of the XV International Scientific and Practical Conference*
- [9] Poleshkina I 2019 Polyfunctionality of the transport system of the northern regions *World of transport* vol 2
- [10] Poleshkina I 2018 Evaluation of efficiency of food supply of the regions of the far north of russia *Materials of the XV International Scientific and Practical Conference*
- [11] Nair A and Jayaram J 2012 Strategic purchasing participation, supplier selection, supplier evaluation and purchasing performance *International Journal of Production Research* vol 2
- [12] Chiang C 2012 An empirical investigation of the impact of strategic sourcing and flexibility on firm's supply chain agility *International Journal of Operations & Production Management* vol 32
- [13] Chiang C 2017 Cooperative strategy in supply chain networks *Industrial Marketing Management* vol 41
- [14] Barney J 2010 Purchasing, supply chain management and sustained competitive advantage: The relevance of resource-based theory *Journal of Supply Chain Management* vol 48
- [15] Wadhwa S and Mishra M 2012 Effects of information transparency and cooperation on supply chain performance: a simulation study *International Journal of Production Research* vol 8
- [16] LeMay S and Helms M 2017 Supply chain management: the elusive concept and definition *International Journal of Logistics Management* vol 1