

# Improvement Opportunities in Commodity Trucks Delivery in Globalized Markets

## *Prilike za poboljšanje isporuke robe kamionima na globaliziranome tržištu*

Irina Makarova

Kazan (Volga Region) Federal University  
Naberezhnye Chelny, Russia  
e-mail: kamIVM@mail.ru

Rifat Khabibullin

Kazan (Volga Region) Federal University  
Naberezhnye Chelny, Russia  
e-mail: hrg\_kampi@mail.ru

Eduard Belyaev

Kazan (Volga Region) Federal University  
Naberezhnye Chelny, Russia  
e-mail: bomund@mail.ru

Vadim Mavrin

Kazan (Volga Region) Federal University  
Naberezhnye Chelny, Russia  
e-mail: vadim\_mmite@rambler.ru

DOI 10.17818/NM/2016/1.3

UDK 339.1

Review / Pregledni rad

Paper accepted / Rukopis primljen: 28. 8. 2014.

### Summary

Market globalization has posed the problem of finding economical routes of product delivery one of which is via a system of intermodal motor traction. Currently, the automotive manufacturing plant KAMAZ supplies its products and accompanying servicing to countries in Europe, Asia, Africa and Latin America, and intends to extend the market. This study deals with peculiarities of the organization of spare parts delivery to the dealer-service network abroad. Risks of water haul are considered; methods for improving of transportation planning by developing a decision support system are proposed.

### KEY WORDS

Northern Sea Route  
automotive manufacturing plant  
product delivery  
transportation planning  
decision support system

### Sažetak

Globalizacija tržišta stvorila je problem pronalaska ekonomskih ruta isporuke proizvoda (jedan od njih je sustav intermodalnoga motornog prijevoza). Trenutno automobilsko proizvodno postrojenje KAMAZ opskrbljuje svojim proizvodima i pratećim uslugama zemlje Europe, Azije, Afrike i Latinske Amerike i namjerava proširiti tržište. Ova studija bavi se specifičnostima organizacije isporuke rezervnih dijelova do mreže pružanja usluga u inozemstvu. Razmatrani su rizici vodnog prometa; predložene su metode poboljšanja planiranja transporta razvijanjem sustava podrške odlukama.

### KLJUČNE RIJEČI

sjeverna pomorska ruta  
automatsko proizvodno postrojenje  
isporuka proizvoda  
planiranje prijevoza  
sustav podrške odlukama

## 1. INTRODUCTION / Uvod

Economic globalization has extended the distances between producers and consumers, dramatically increasing the traffic flow volumes. For producers it is critical, in view of the rapid advancement of processes and technologies and global competition, to continue designing novel complex, science-intensive products to expand the markets and become attractive for consumers. For manufacturers of automotive vehicles, ambitious to extend the market, this implies searching for ways of improving the logistical processes to accelerate the delivery of vehicles and spare parts to consumer. The realization of logistical systems depends on how dynamic is the development of transport systems uniting regions, states, and continents. Intermodal transport, involving different kinds of transport, represents a complex system whose stability depends on a variety of factors determining, among other things, the state of infrastructure and the quality of decision making. Following a comprehensive approach, the efficiency of logistic chains depends on the quality of interaction of

subsystems, their interconnection and selected management variant. Rational management can be based on decision support systems, which enable to intellectualize the options of product delivery in analysis of multi-criteria decision making.

## 2. LOGISTICAL SYSTEMS AT GLOBALIZED

### MARKETS / Sustavi na globaliziranim tržištima

#### 2.1. Peculiarities of modern transport logistical systems / Posebnosti sustava modernoga logističkog transporta

The transport system nowadays incorporates all kinds of transport including the water-borne transport connecting the continents [1]. The turnover of maritime shipping is the largest in volume due to the fact that the load capacity of sea-going merchant ships by far exceeds that of railroad trains. Moreover, since the natural sea routes do not require maintenance expenditures and the overall labor costs are moderate due to low staffing, the cost of seaborne shipment has remained one

of the lowest in transportation [2].

All means of maritime transport are being continuously updated. This includes enhancing of load capacity, speed and safety of the ships, intensifying of handling operations by employing containers, and other innovations. As a result, the intensity of logistical operations increases while the summary capacity of the fleet and seaports diminishes. Maritime transport has been incorporated into a general logistical system so that the seaports are now transformed into large logistics clusters providing an interface for different kinds of transport, of railway and automotive transports in the first place. Mixed traffic needs coordination which is best achieved by creating logistical intermodal transportation. Intermodal container-transport systems widely used nowadays require intermodal container terminals. Such terminals exist in Russia, the largest located in the seaports of St. Petersburg and Novorossiisk.

When selecting ways of cargo transportation in Russia, we should bear in mind the substantial, though insufficiently utilized, potential of its inland waterways. Having lost 11 seaports out of 18 in 1991 and a half of marine shipping, Russia has to turn to river transport in foreign trade using ships of mixed navigation. Transportation by ships of the river-sea type is more economical compared to conventional transportation along inland waterways because the routes are longer and the ships can be used on nonfreezing marine areas after closing of river navigation in winter.

Nowadays it is important to integrate different traffic arteries and junction points and the modern logistics proper, i.e. cargo reception, transloading, handling, customs operations, etc. For efficient functioning of intermodal container shipping it is necessary to optimize interacting of all links of the supply chain based on systemic approach to process coordination in a system. This involves introducing of advanced technologies including the computerized systems supplied with appropriate program packages and navigation systems such as GLONASS, which is also expected to promote the development of electronic engineering in Russia.

## 2.2. Prospects for the development of marine transport / *Perspektive razvoja pomorskog transporta*

In 1990, the USSR came fourth in the total merchant tonnage after Liberia, Panama and Japan. After the merchant fleet was split between the CIS and Baltic states, Russia inherited the ships with a carrying capacity of 10.6 mln deadweight, that is, a little over a half of the cargo fleet tonnage at the command of the erstwhile USSR Minflot Ministry. The condition of the marine fleet deteriorated throughout the 1990s, both in terms of quantity (as a result of removing of obsolete vessels from service, which diminished the total tonnage, and of selling ships illegally to offshore companies), and in terms of quality of operations. Therefore much of the Russian cargo fleet became uncompetitive at the world freight market. Another part of the fleet was engaged in shipping for foreign companies, whereas the domestic export-import cargoes were transported by foreign ships. The trend was reversed by adopting a special

program of development for the merchant fleet [3] within the framework of the general strategy of the transport system development in Russia [4]. Currently, the marine transport is mostly used in foreign trade while the share of coastwise shipping is still insignificant.

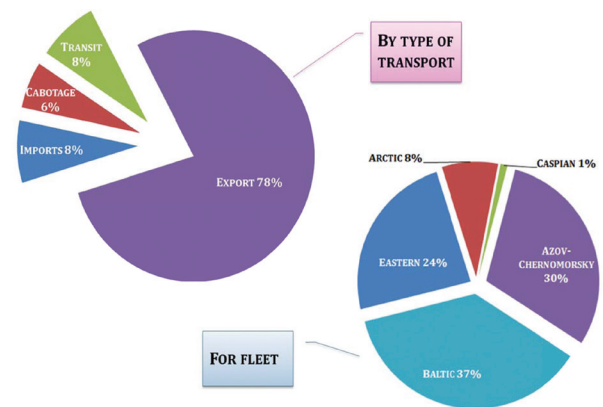


Figure 1 Cargo turnover of Russian ports  
*Slika 1. Obrtaj broda u ruskim lukama*

Although maritime transport does not require creating of an infrastructure for cargo shipping, with the exception of port terminals, the scale of sea traffic is such that some of the seas get virtually crowded. Thus, the Mediterranean may accommodate as many as 2.5 thousand merchant ships at a time, this not counting the coastal ships; the Baltic Sea - 800; the South China Sea - more than 700. Traffic intensity is at its highest at junction points, such as the sea straits and the approaches to global seaports [5]. In these conditions, shipping becomes restrained not only by man-made canals but also by natural sea straits. Restrictions emerge both as a result of extreme traffic density, which is fraught with accidents in the case of poor navigation conditions, and due to the fact that many of the sea straits have become inaccessible to huge cargo carriers, supertankers in the first place. This creates risks that are to be taken into account when selecting the optimal logistics chain.

In Russia, 60% of the ports are too shallow for handling of large ships. This challenge is addressed by the ongoing programme of reconstruction of the existing ports and constructing of new ones, for instance, at the Baltic Sea. Although the greatest cargo facilities have been constructed in the Pacific Ocean ports (Vostochny, Vladivostok, Nakhodka), their full capacity operation is still hindered by remoteness from the better developed Russian regions; so the summary cargo turnover of the Pacific ports is even lower than that of the Baltic and Azov-Black Sea ports (Fig. 2). The second in size and first in importance are the ports of the Baltic Sea having a favorable geographic location. The Black Sea ports (Novorossiisk, Tuapse) cater for the oil export from Russia, Azerbaijan and Kazakhstan, but shipping there is limited because of the significance of the Black Sea coast as a recreation area.

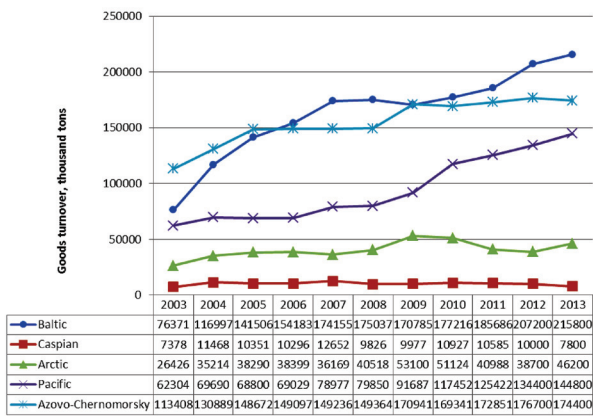


Figure 2 Seaborne freight turnover  
Slika 2. Obrtaj tereta prevoženog morem

Another path of transportation, with a great potential for development, is the Northern Sea Route, running along the Arctic seas and representing the shortest way between Europe and Asia. The route of Murmansk-Dikson-Tiksi-Pevok Bay-Bering Strait-Petropavlovsk-Kamchatski is already utilized in supplying the Extreme North settlements with food, building materials and fuel.

In Russian economy, it is impossible to overestimate the role of the river transport owing its importance not to the scale of operations but rather to the significance of functions it performs. The river transport is vitally important for the country's northern and eastern regions, where the density of interior waterways is twice as large as Russia's average, whereas the railroad network density is inadequate. Besides acting as a transport service for Siberia and the Far East, including the Arctic, the river transport performs complex and costly transportation operations along the minor rivers in remote regions, and also the highly remunerative shipping of export goods by mixed river-sea going ships. The length of navigable water ways is 101th km of which 70% are sufficiently deep during the navigation period. In the European part of Russia, the previously isolated water ways have been connected by canals (Belomorsko-Baltiysky, Volgo-Vyatsky, Volgo-Donsoy) to form a unified deep-water transport system connecting the White, Baltic, Caspian, Azov and Black Seas. The unified deep-water system (UDWS) is 6.5th km long, with a

guaranteed depth of 4m practically along the entire network. The UDWS handles more than a half of turnover of the inland water transport.

In 2012 was signed the law "On Making Changes to Some of the Russian Federation Code in the Part of Government Regulation of Merchant Shipping along the Northern Sea Route". By codifying this water area Russia has taken the responsibility of warranting the safety of navigation for any ship, icebreaking and pilotage services, emergency aid, and access to the shore infrastructure. The Law specially stipulates the measures to be taken for protection of the Arctic wildlife including the financial provisions against the liability of damage to the environment for ship owners of freighters sailing along the NSR,

Developing of the NSR will enhance the potential of the Russian icebreaking fleet. Currently, the NSR is being serviced by nine linear icebreakers five of which are nuclear-powered, including the "50 Years of Victory" built in 2007, and four are diesel-powered. The icebreaker fleet is being developed within the federal special-purpose program "Development of the Transport System of Russia for the period of 2010-2015". In 2012 was launched the construction of two new icebreakers at the Baltic and Vyborg shipbuilding yards with the capacity of 25 MWt and 16 MWt. In 2013 the Rosatom (the Russian Federal Atomic Energy Agency) conducted two competitive selection processes for construction of two multi-purpose follow-on atomic ice-breakers on the Project 22220. The ships are planned to be built during 2014 - 2019 and 2015 - 2020. Due to their technical characteristics, these multi-purpose ice-breakers will operate equally well in Siberian river estuaries and along the NSR. Moreover, they will surpass their worldwide analogues in size and power due to broader hulls (34 m compared to 30 m in atomic ships of the Arktika type). Each of the new atomic ice-breakers will be capable of piloting tankers of up to 70 th t, crushing an up to 3m- thick ice.

Nowadays the Arctic has a chance to realize its international traffic potential and become an impressive investment site. This opinion is held by both near-Arctic states, the permanent members of the Arctic Council, i.e. Denmark, Iceland, Canada, Norway, Russia, USE, Finland and Sweden, having their natural interest, and the EU, APR and developing countries. According to

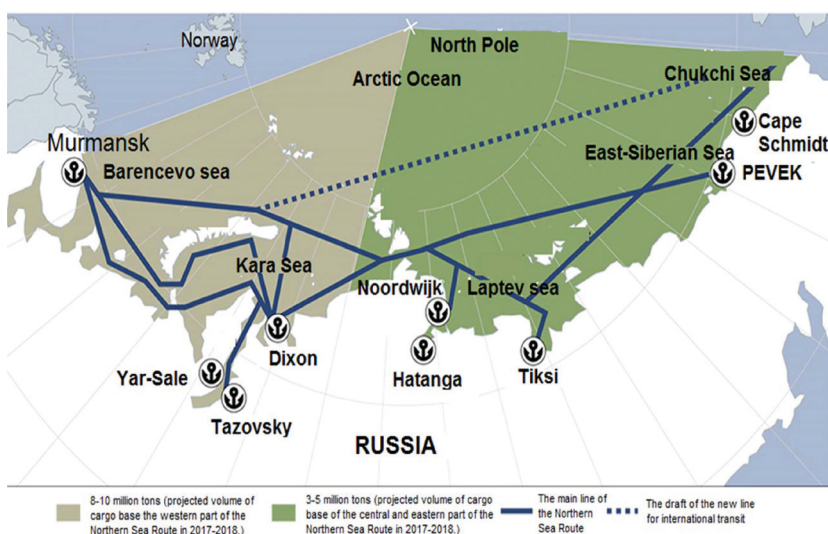


Figure 3 Freight traffic along the Northern Sea Route  
Slika 3. Promet tereta duž Sjeverne morske rute

the international law, they all may operate in the free economic zone of the Arctic, and according to the UNO convention (UNCLOS) any ship may have a peaceful passage through the 12-mile territorial waters of the near-Arctic states. For instance, China, the world export leader and a major EU trading partner, will benefit with the new reliable and safe route of cargo delivery because passing of marine merchant caravans from Shanghai to Hamburg via the Bering Strait and following the NSR diminishes the shipping time by 40%. According to Chinese experts, the economy from only one northern-route voyage of a bulk or container carrier will make up USD 0.5 to 3.5 mln due to smaller fuel consumption, freight payment, labor expenses, etc. Another advantage is the absence of pirates in the high latitudes as is the case in the Strait of Malacca and the Gulf of Aden.

Thus, the author of work [6] assesses the impact of the ice-free Arctic on the development of marine transport industry in China discussing the potential new routes and the opportunities that it brings to China's maritime transportation

On the other hand, while enumerating China's benefits from the possible opening of the NWP (over North America) and NSR (over Eurasia) that would cut the existing oceanic transit times by days, saving shipping companies thousands of miles in travel, the author of work outlines the challenges including both political ones, i.e. the sovereignty and security issues, evolving relationships between the circumpolar states and the non-Arctic actors, such as the European Union, China, Japan and South Korea and environmental.

It is said that China should not underestimate the accidental spills of oil and chemicals accompanying the increased shipping activities in the Arctic. These challenges may be overcome by enhancing a polar code for shipping, improving the SAR services in the Arctic, building up the Arctic marine infrastructure and

Table 1 Comparative analysis of cost flights bulk carrier of 70,000 tons from Kirkenes (Norway) in Yokohama (Japan) through the Suez Canal and the route using the Northern Sea Route

*Tablica 1. Komparativna analiza troška broda za rasuti teret od 70000 tona iz Kirkenesa (Norveška) do Jokohame (Japan) kroz Sueski kanal i ruta koja koristi Sjevernu morsku rutu*

Indicators of cost	Through the Suez Canal	Northern Sea Route
Fuel consumption total -	\$ 1 million in 44 days	\$ 601,000 in 26 days
in a day -	33 tons at \$ 700 per 1 ton	33 tons at \$ 700 per 1 ton
Freight costs total -	\$ 720,000 for 48 days	\$ 450 000 for 30 days
in a day -	\$ 15 000 per day	\$ 15 000 per day
The fee for the passage through the Suez Canal	\$25 000	no
The fee for icebreaking support of the Northern Sea Route	no	\$375 000
Fee for service at the ports	\$250 000	\$250 000
Incidental expenses (towing in port, and others.)	\$50 000	\$50 000
Additional premium for the risk of piracy in the Gulf of Aden	\$110 000	no
General insurance premiums for passage through the Northern Sea Route	NO	\$70 000
In total	\$ 2.38 million and 48 days	\$ 1 796 000 and 30 days

adopting an environment friendly approach to protect the ecosystem of the Arctic from any consequences associated with future commercial shipping in the Arctic. Ways should be further developed of partnership and cooperation so that peace, stability and sustainable development in the Arctic will serve the common interest of both Arctic and non-Arctic states.

### 2.3. Risks associated with maritime trade / Rizici koji su povezani s pomorskom trgovinom

Both the reliability and sustainability of logistics systems are prone to be affected by external and internal risks. External risks are associated with natural disasters, macroeconomic and political fluctuations that are beyond control of the Russian Federation. External risks can only be managed indirectly (such as via governmental negotiations in top-level international organizations). These risks include:

1. Macroeconomic risks, which are likely to aggravate both the external and internal market conditions, diminish the economic growth and investment activities, cause bank crises, industrial recession, etc. For instance, the Caspian region happens to be surrounded by several troubled areas preventing the sea ports development.
2. The critical factor is instability of world prices for energy products which, along with metallurgical products, are shaping the bulk of Russia's cargo traffic.
3. Unfriendly behavior of other states towards Russia. Now most of Russia's export transport capacities are located in its West-European part, mainly at the Baltic and Black Seas. Thus, it is highly probable that unfriendly acts on the part of Turkey or allied near-Baltic states may hinder the implementation of a number of large infrastructural projects. Negative consequences in this case can be diminished through phased diversification and development of infrastructure ensuring the export-import shipping along the Northern, Far-Eastern and Caspian routes.
4. Geopolitical risks. Integrating into the international transport system depends on the stability of political situation in adjoining regions. For instance, the implementation of the project of the North-South international transport corridor may be jeopardized in the case of deterioration of relations or of an armed conflict between Iran and US. Similarly, worsening of our relations with the neighbouring countries in the Far East will make less attractive and competitive the Trans-Siberian railroad.

The internal risks may be caused by changing economic and political situations within the country, their influence is predictable and can be staked off by resorting, for instance, to legal actions by economic entities. These risks include:

1. Restrictions imposed on the development of ports and near-port infrastructures. Due to in-city location, the ports are hindered in extending of their infrastructure, renovating of road and railroad siding facilities and creating of logistics centers.
2. The ports are not self-sufficient in dealing with cargo transportation, being links in a transport-logistical chain. Therefore new techniques of managing the transportation process, based on logistics principles, are required. The tools of these techniques are the transport and logistics hubs based on sea ports. Transport hubs have also become significant due to the fact that a port is no longer a single



enterprise. Cargo handling operations are now performed by different stevedoring and other companies. This hinders the business activities, interaction with the railroad, in particular.

3. Insufficient capacities for trans-loading of imported cargo (containers and rolling cargo) due to recent priority development of export trans-load facilities.
4. Inadequate organization of border check points, with lengthy customs procedures, slowing down the port activities.
5. Unbalanced and unreasonable utilization of budgetary funds allocated to the development of sea ports infrastructure.
6. Diminished budgetary financing. Notwithstanding the anticipated increase in private investment to the transport complex, some of the strategically and socially significant projects cannot be realized without different-level budgetary investment.
7. Perfecting of tariff setting rules. The present structure and level of harbor dues, standardization of railroad tariffs for seaport-bound trains, and on-land frontier crossing are ineffective, especially in the Far East and the North-West (Kaliningrad).
8. Legal risks. The transport industry will develop dynamically and efficiently if only the federal laws on "Transport safety", "On Service Concession Agreement", "On Seaports of the Russian Federation" and others are adopted. There are still legal uncertainties regarding the reservation and utilization of land sites for construction and renovation of ports, including the issues of delineating of the land and water areas of sea ports and categorizing the occupied areas as transport land.
9. Technogenic and environmental risks and natural disasters. Natural and ecological disasters should be taken into account when developing the port facilities and estimating the probability and scale of damage to the marine transport infrastructure and transport means that may be caused by earthquakes, seismic sea waves and other natural disasters.

When creating a logistics system, we should provide a risk-sensitive basis for the logistics chains. Efficient risk monitoring relies on a system of measures providing a prompt response to risk situations. Thus, researching the NSR potentials, experts note its disadvantage of seasonality, adding that shipping operations in the summer time via the NSR may already today be profitable for minor bulk trades [7]. Additional shipping routes may give more flexibility, and the NSR route choice option may facilitate supply chain agility and adaptability.

Work [8] identified the economic, external, and internal drivers and barriers to sailing along the NSR from the perspective of shipping companies. Data were collected from three Korean shipping companies comparable in size and type of shipped cargo, which considered the NSR voyage in 2013.

What are the drivers and barriers of sailing the NSR? This study aims to address this question by identifying the economic, external, and internal drivers and barriers to voyage through the NSR, from the perspective of shipping companies.

Primary research methodology of this study is comparing case studies, through data collection, with in-depth interviews and documents. Three Korean shipping companies were chosen as specific cases in this study, according to three sampling criteria. It was necessary to select shipping companies that are

registered in the same country, in the case of this study, Korea, in order to control country-level impacts on their behaviors. Second, three companies were selected because, based on news articles, all three initially considered the NSR voyage in 2013 [9, 10]. Third, these three companies are appropriate for a case study due to their comparable size; they are affiliates of the top 30 large-scale companies in Korea based on financial status (total assets amount, total capital, total debt amount, and debt ratio). Hyundai Glovis is an affiliate of Hyundai Motor Group while Hanjin Shipping belongs to Hanjin Group. Hyundai Merchant Marine is an affiliated company of Hyundai Group. All these shipping companies operate bulk and tankers as well as containerships.

To be economically viable, the resource and energy development in the region could facilitate NSR voyages. However, international community and policy measures, such as environmental regulation in the Polar Code, become aware of the risks of resource development in the region. In addition, shipping companies that would plan to utilize the NSR also need to consider strengthened environmental regulation. Furthermore, there are a variety of barriers that shipping companies cannot control. Except for internal barriers such as leadership's reluctance and financial shortage, domestic and Russian regulations, natural resource development and marketable ports buildup in the region can be hurdles for further NSR voyage.

Among the factors hindering the NSR voyages are strengthened environmental regulations, leadership's reluctance and financial shortage, domestic and Russian regulations, natural resource development and marketable ports buildup in the region.

Another risk discussed in work [11] consists in inaccuracy of weather and sea-ice forecasts due to sparse observational network in the Arctic. Experiments have shown that additional radiosonde observations can improve predicting of persistent strong wind events.

Accurate forecasts of weather and sea ice are desirable for safe navigation, but large uncertainties exist in current forecasts, partly owing to the sparse observational network over the Arctic Ocean. Here, we show that the incorporation of additional Arctic observations improves the initial analysis and enhances the skill of weather and sea-ice forecasts, the application of which has socioeconomic benefits. Comparison of 63-member ensemble atmospheric forecasts, using different initial data sets, revealed that additional Arctic radiosonde observations were useful for predicting a persistent strong wind event. The sea-ice forecast, initialised by the wind fields that included the effects of the observations, skilfully predicted rapid wind-driven sea-ice advection along the NSR.

The authors of work [12] consider that, when the Panama and Suez Canals reach capacity, capital investment to the NSR will be increasing notwithstanding inadequate hydrographic information, narrow and shallow straits, search and rescue assets and severe polar laws.

As an emerging transit route option for global maritime shipping, the NSR has long since proven its viability to sustain regional markets and add value to its port communities. While Arctic sea ice reduction is piquing international interest in the NSR regarding transportation and logistics, use of the NSR is not without weighty challenges. The most notable are the lack of

comprehensive hydrographic information, narrow and shallow straits, inadequate search and rescue assets and formidable polar lows. Opportunities for maritime transportation include the creation of an Arctic trans-shipment market and efficiencies gained by shorter transit distances, energy reduction, piracy avoidance, etc. As current global trade routes through the Panama and Suez Canals reach capacity, we do not doubt that capital investment into the NSR will increase and it will become an attractive and efficient transportation option for international markets.

Another important factor is the adequate assessment of the reliability of the supplier. When evaluating the supplier's reliability, many of the authors highlight the factors coming to the forefront when considering alternatives in decision making. There are different methods proposed for multi-criteria analysis. Thus, the authors of work point out that the extensive multi-criteria decision making approaches, proposed for supplier selection, include the analytic hierarchy process (AHP), analytic network process (ANP), case-based reasoning (CBR), data envelopment analysis (DEA), fuzzy set theory, genetic algorithm (GA), mathematical programming, simple multi-attribute rating technique (SMART), and their hybrids.

This review contains researches made between the 2000s and 2008s. These methods were furthered in later studies. Thus, the review [13] reports of works using analytical and empiric methods for selecting of strategic suppliers. In work [14] it is said that evaluating of strategic supplier performance is one of the important functions within a supply chain, with the integrated QFD-AHP method being effective but needing a customized approach to adopt it within the industry.

Strategic supplier performance evaluation is one of the important functions within supply chain. The integrated QFD-AHP method for supplier evaluation is effective, but it needs a customized approach to adopt it within the industry.

In the authors' opinion, further research should be aimed at checking the effect of other factors affecting the supplier selection, and also at developing of dynamic methods for rapid reevaluation.

The authors of work [15] have pioneered the application of hesitant fuzzy methodology in preference elicitation for strategic supplier selection. This study focuses particularly on the following circumstances: multiple strategies of companies, multiple stakeholders involved in decision processes, and multiple perspectives with uncertainties and conflictions.

The authors report [16] that expert estimation is often made difficult by insufficient volume of available expert samples.

The approach they take in evaluating and selecting of sustainable suppliers is a triple-bottom-line (profit, people and planet) one, in which both business operations, environmental impacts and social responsibilities of the suppliers are considered. The authors have introduced a new methodology for supplier selection using Bayesian theory and Monte Carlo simulation with a Gibbs sampler. The Bayesian theoretic methodology of selecting suppliers, introduced in this work, uses various dimensions of the sustainability's triple-bottom-line approach, i.e. business operations, environmental concerns, and social responsibility which effectively discerns the suppliers performance and aids in supplier selection.

## 2.4. Developing of an intellectual system for optimization of logistic support / *Razvijanje intelektualnog sustava optimizacije logističke podrške*

For analysis and development of Markets extension and continuing emergence of new models and modifications of vehicles prompt the appearance of new modes of delivery of both vehicles and spare parts to car dealers. Besides, since observing of the service warranty obligations entails the delivery of spare part kits for each vehicle consignment, this requires developing of tools for collecting, storing and analysing of large and reliable data bodies about deliveries. An optimal tool enabling to promptly react to changing internal and external parameters in large systems is a decision support system (DSS) operating on technologies using online databases, data storage, systems of online data processing, and intellectual data analysis. The DSS incorporates a set of interconnected models with appropriate information support, and expert and intellectual systems storing the experience of solved managerial problems and ensuring the participation of expert groups in the decision making process.

Analysis and producing of recommendations in a DSS are based on data retrieval, intelligent data analysis, knowledge search in the database, precedent-based reasoning, simulation modeling, evolutionary computation and genetic algorithms [17], neural networks, situational analysis, cognitive modeling, etc. In the case a DSS relies on methods of artificial intelligence, it is regarded as an intelligent DSS, or an IDSS. The DSS design essentially depends on the number of tasks it is to tackle, on accessible data, information and knowledge, and the system's users. A DSS consists of three parts:

1. A system for collecting and storing of the data obtained from internal and external sources, i.e. a database.
2. A dialogue system allowing the user to enquire which data should be selected and how they should be treated.
3. A system of models, i.e. ideas, algorithms and procedures for processing and analyzing the data. While retrieving the data, the user has his/her own experience, knows the situation and is guided by certain considerations. Data processing involves various techniques ranging from plain summation to statistical analysis and nonlinear optimization. The conceptual diagram of a DSS is presented in Fig. 4.

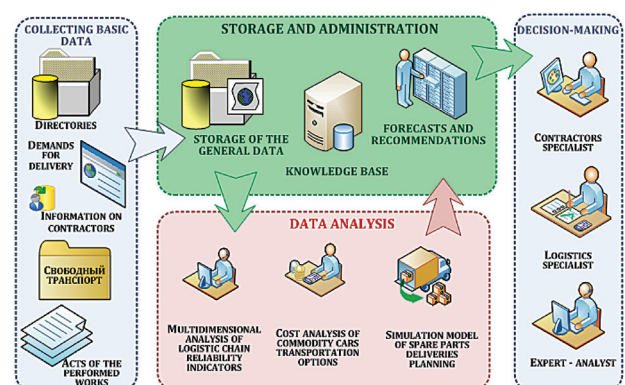


Figure 4 Conceptual diagram of DSS  
Slika 4. Konceptualni dijagram DSS

Since decision making is based on the real data about the managed object, analysis and adoption of strategic decisions involve aggregated information stored in data warehouses (DW). The DW is built for integrating, actualization and coordinating of the operative data from heterogeneous sources in order to form a single and consistent view of the entire object under management.

The selection algorithm, incorporated in the model, presupposes the availability of several variants of cargo delivery along each of the routes (Fig.5.).

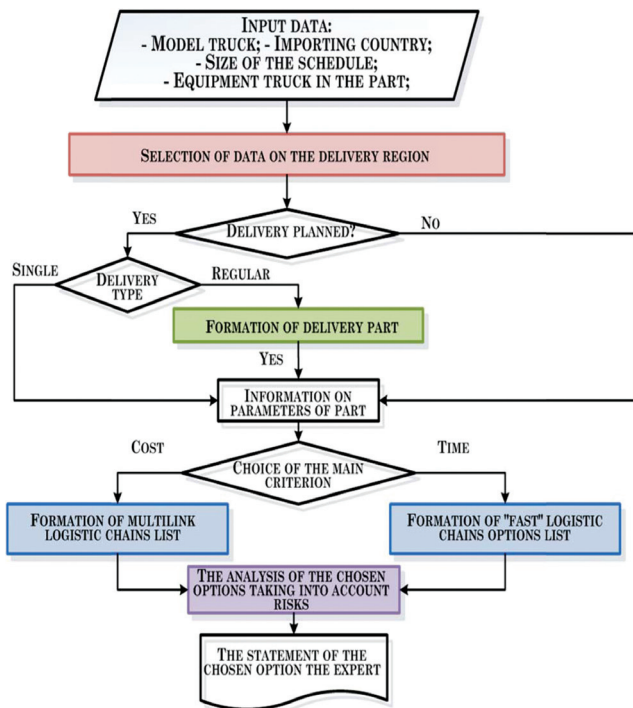


Figure 5 Variants of logistical chains  
Slika 5. Varijante logističkog lanca

Each of the routes is characterized by a great number of factors that can affect both the quality and time of delivery, Besides, deliveries along the multi-link chains may take longer time due to uncoordinated operations of different kinds of transport and transfer units.

By way of example, an important task in interaction with foreign dealers is planning of spare parts deliveries, which depends on the critical level of parts in DSC warehouses and determined by the point of time when the level of stored parts either falls below the minimum (tk1) or becomes 0 (tk2) upon the application receipt (Table 1).

Table 1 Criticality Levels Values  
Tablica 1. Vrijednosti kritičkih razina

Value $t_k$	Restrictions	$t_k < t_1$	$t_1 \leq t_k < t_2$	$t_2 \leq t_k$
$t_{k2}$		6	4	2
$t_{k1}$		5	3	1

The critical level of 1-2 implies that no correction of the delivery schedule is needed; at 3-4 the schedule must be corrected. The level of 5-6 signifies a high probability of certain

parts missing in the DSC warehouse in case of failure. This signifies that the schedule is to be immediately corrected and alternative ways of delivery searched.

If the database contains ready-made optional solutions, it is possible to make selection from the available variants; otherwise solutions are searched by using an imitation model. The model restrictions are:

$$\sum_{i=1}^N m_i \cdot n_i \leq U_l, \quad (1)$$

$$\sum_{i=1}^N v_i \cdot n_i \leq V_j, \quad (2)$$

where  $m_i$  is the weight of the  $i$ -th names of spare parts,  $kg$ ;  $U_l$ - capacity of  $l$ -th vehicle used for deliveries in a given region,  $kg$ ;  $n_i$  - volume of  $i$ -th names of spare parts,  $m^3$ ;  $V_j$  is the capacity of the  $j$ -th vehicle used for deliveries,  $m^3$ . his approach has been realized in a DSS module "Recommendations for accumulation of spare part lots" (Fig.6).

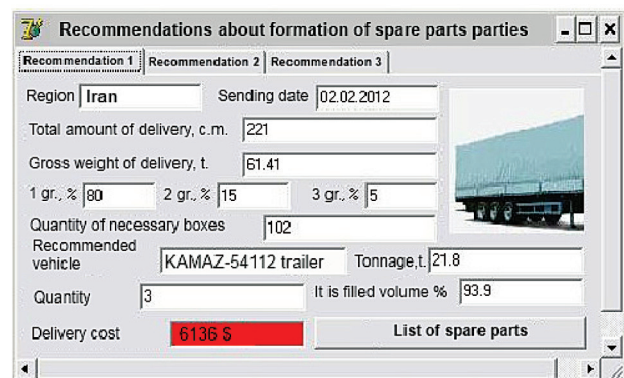


Figure 6 Module window affording to select a variant of spare parts delivery

Slika 6. Prozor modul koji omogućava odabrati varijantu isporuke rezervnih dijelova

### 3. CONCLUSION / Zaključak

By using the developed DSS for multifactor analysis of variants for delivery of spare parts and automotive vehicles, risk account and delivery scheduling it is possible to enhance the efficiency of logistical processes and the competitive potential of a manufacturer.

### REFERENCES / Literatura

The references are listed in the order of appearance in the paper in the following manner:

- [1] Zeyan Zhang, Miguel Andres Figliozzi: A Survey of China's Logistics Industry and the Impacts of Transport Delays on Importers and Exporters, *Transport Reviews: A Transnational Transdisciplinary Journal*, 30:2, pp. 179-194, 2010
- [2] Paul T.-W. Lee, Kai-Chieh Hu, Tao Chen: External Costs of Domestic Container Transportation: Short-Sea Shipping versus Trucking in Taiwan, *Transport Reviews: A Transnational Transdisciplinary Journal*, 30:3, pp. 315-335, 2010
- [3] Transport strategy of developing maritime activities in the Russian Federation for the period until 2030. Adopted by the government decision as of 8 December, 2010 № 2205-p <http://base.consultant.ru/cons/cgi/online.cgi?req=doc;base=LAW;n=107955>
- [4] Transport Strategy of the Russian Federation for the period until 2030. Adopted by decision of the Government of the Russian Federation as of 22 November 2008 № 1734-p [http://mintrans.ru/documents/detail.php?ELEMENT\\_ID=13008](http://mintrans.ru/documents/detail.php?ELEMENT_ID=13008)
- [5] Pedro Simões, Rui Cunha Marques: Influence of Congestion Efficiency on the European Seaports Performance: Does It Matter?, *Transport Reviews: A Transnational Transdisciplinary Journal*, 30:4, pp. 517-539, 2010
- [6] Nong Hong. The melting Arctic and its impact on China's maritime transport,

- Research in Transportation Economics, 35, pp. 50-57, 2012. <http://dx.doi.org/10.1016/j.retrec.2011.11.003>
- [7] Halvor Schøyen & Svein Bråthen. The Northern Sea Route versus the Suez Canal: cases from bulk shipping, *Journal of Transport Geography*, 19, pp. 977–983, 2011. <http://dx.doi.org/10.1016/j.jtrangeo.2011.03.003>
- [8] Taedong Lee & Hyun Jung Kim. Barriers of voyaging on the Northern Sea Route: A perspective from shipping Companies, *Marine Policy*, 62, pp. 264–270, 2015. <http://dx.doi.org/10.1016/j.marpol.2015.09.006>
- [9] NSR, Is it a 'sea route of miracle'. The Kyunghyang Shinmun, Weekly Khan November 12, 2013.
- [10] Hyundai Merchant Marine, Hanjin Shipping and Hyundai Glovis will navigate on the NSR. JoongAng Ilbo July 18, 2013
- [11] Jun Inoue, Akira Yamazaki, Jun Ono, Klaus Dethloff, Marion Maturilli, Roland Neuber, Patti Edwards & Hajime Yamaguchi. Additional Arctic observations improve weather and sea-ice forecasts for the Northern Sea Route // *Scientific RepoRts* | 5:16868 | DOI: 10.1038/srep16868 / <http://www.nature.com/scientificreports/> <http://dx.doi.org/10.1038/srep16868>
- [12] Emmaline Hill, Marc LaNore & Simon Véronneau. Northern sea route: an overview of transportation risks, safety, and security, *Journal of Transportation Security*, 8:3, pp. 69-78, 2015. <http://dx.doi.org/10.1007/s12198-015-0158-6>
- [13] Ho, W., Dey, P.K., Bhattacharya, A. Strategic supplier selection using multi-stakeholder and multi-perspective approaches, *Int. J. Production Economics*, 166, pp. 152–154, 2015. <http://dx.doi.org/10.1016/j.ijpe.2015.03.028>
- [14] Dey, P. K., Bhattacharya, A., Ho, W. Strategic supplier performance evaluation: A case-based action research of a UK manufacturing organization, *Int. J. Production Economics*, 166, pp. 192–214, 2015. <http://dx.doi.org/10.1016/j.ijpe.2014.09.021>
- [15] Chai, J, Ngai, E.W.T. Multi-perspective strategic supplier selection in uncertain environments, *Int. J. Production Economics*, 166. P. 215–225, 2015. <http://dx.doi.org/10.1016/j.ijpe.2014.09.035>
- [16] Sarkis, J., Dhavale, D.J. Dhavale Supplier selection for sustainable operations: A triple-bottom-line approach using a Bayesian framework, *Int. J. Production Economics*, 166, pp. 177–191, 2015., <http://dx.doi.org/10.1016/j.ijpe.2014.11.007>
- [17] Rongrong Li, Yee Leung, Bo Huang, Hui Lin. A genetic algorithm for multiobjective dangerous goods route planning, *International Journal of Geographical Information Science*, 27:6, pp.1073-1089, 2013., <http://dx.doi.org/10.1080/13658816.2012.737921>