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Admiral Makarov State University of Maritime
and Inland Shipping

CURRENT TRENDS IN THE WORLD AND NATIONAL LOGISTICS

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The book contains research papers, which were reported and discussed at the session "Current Trends In the World and National Logistics" of XV International Scientific and Practical Conference "Logistics: Modern Trends of Development" (7–8 April 2016), organized by the Admiral Makarov State University of Maritime and Inland Shipping, St. Petersburg branch of the National Research University Higher School of Economics, Saint-Petersburg State University of Architecture and Civil Engineering. The working language of section was English.

The papers of this proceedings report the results of scientific research in the area of international and urban transport. Papers are published in authors' version.

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FORMAL LOGISTCAL MODEL OF CONTAINER TERMINAL

The article considers the statement of the problem and shows the enlarged model of situational functioning of marine container terminal. Expected results contribute to a process of technological design of new container terminals, and the reorganization of existing terminals.

Key words: *functional model, container terminal*

Introduction

Today containerization is the only direction of the development in general cargo transportation technology. The container terminals display a wide variety, both by geographic regions and routes connecting them. The general appearance of container terminals could be quite different, sometimes even making it difficult to identify their general features.

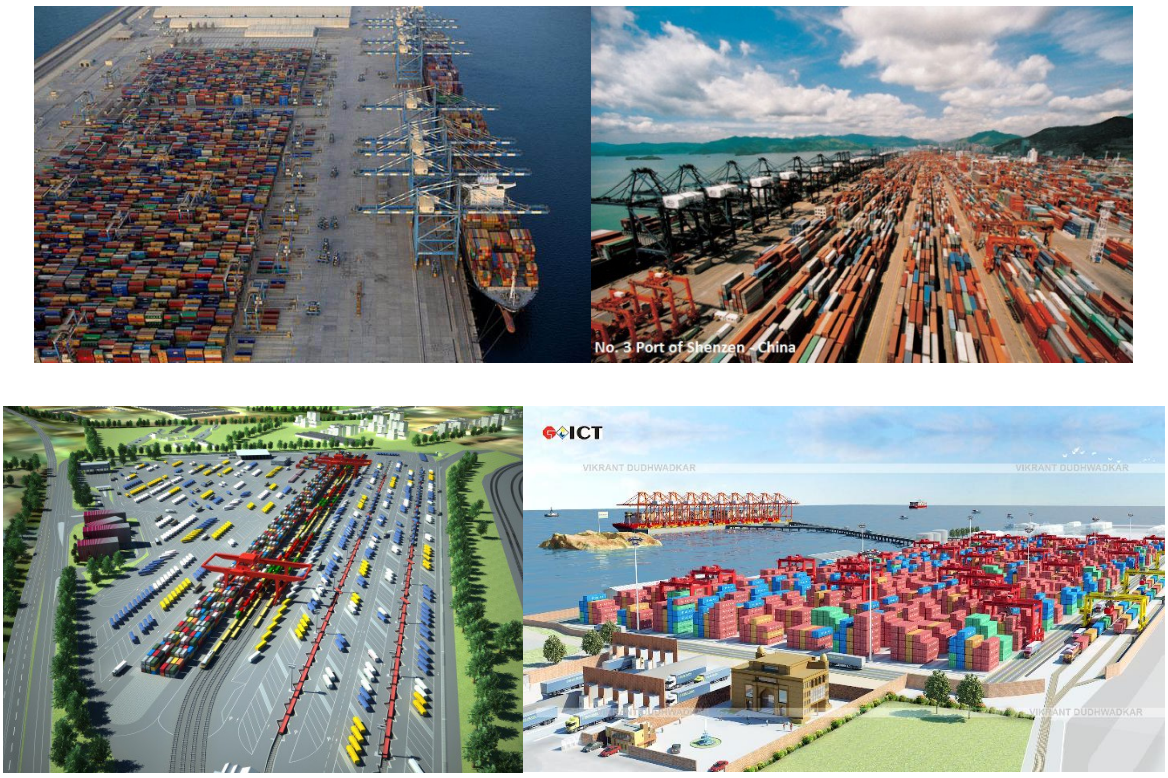


Fig. 1. Container terminal views

Whatever are the scale of container terminal, its position in the hierarchy of trade routes, its functionality and the equipment used, there are certain common basic structural signs, knowledge of which could tell a lot about this key infrastructural element of the most advanced transportation system ever developed in history. This paper describes these structural features common to any container terminal.

The logistical backbone of container transportation system

Any sea port is a node connecting cargo flows conducting by different transportation modes, currying cargo in different directions (Fig. 2).

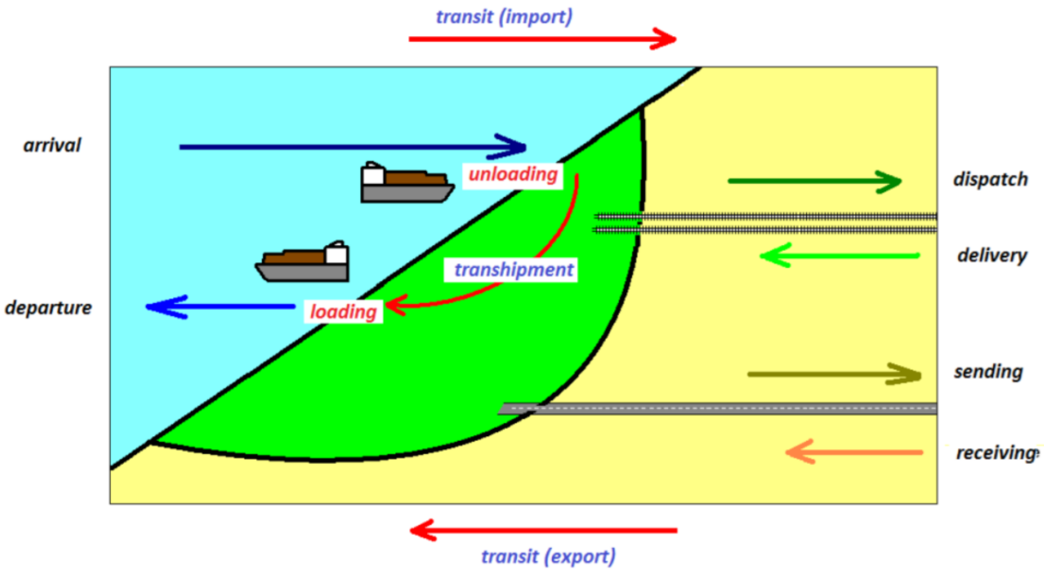


Fig. 2. Port as a node of cargo flows

The historical development of ports is a very complicated phenomenon, influenced by many factors and intensively studied lately by many authors [1–3]. This very important factor (or, more correct, a very complex cluster of factors) that directly concerns many aspects of the object studied here, still lies beyond the scope of this paper. The object under study here is the sea container terminal, specifically the evaluation of its capacity and parameters.

Containerization, firstly introduced in the 1950s [4], was a way to turn break bulk cargo if not into bulk, then into neo bulk [5]. Massive homogeneous cargo was more easy, chipper and quicker to handle, which triggered the economy of scale effect and brought about the phenomenon known as “the collapse of transportation space” [6].

The idea of container transportation was very simple: collecting different pieces of general cargo and placing them into a proper box facilitated the whole process of transportation. The empty box should be returned back to start a new circle of transportation chain, as Fig. 3 shows [7].

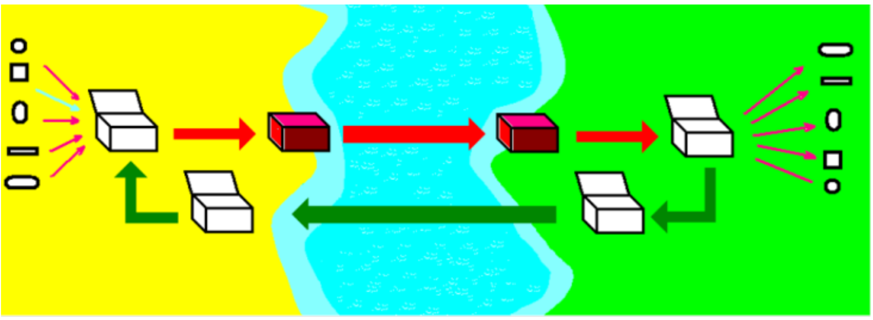


Fig. 3. Idea of container transportation

With the development of this transportation mean, more and more clients of both ends of the link connecting hinterland and foreland would join in, ideally balancing the trade (Fig. 4).

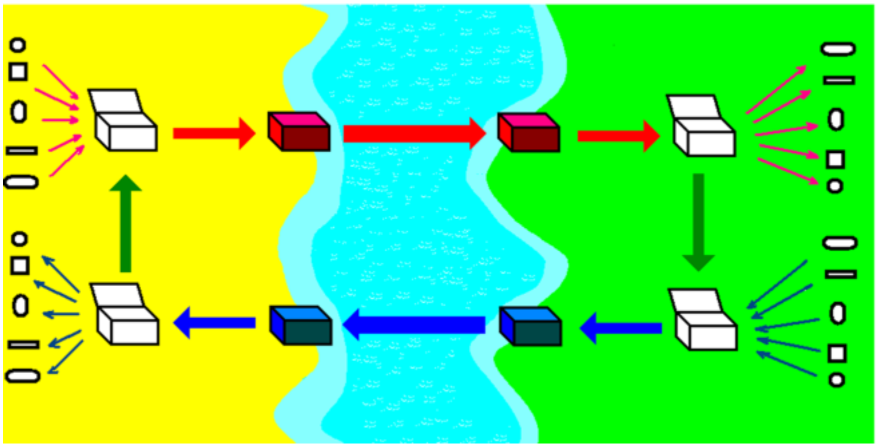


Fig. 4. Balanced container trade

Unfortunately, by economical and geographical reason this idealistic picture could not be observed nearly anywhere, with more realistic imbalanced trade pattern shown by Fig. 5.

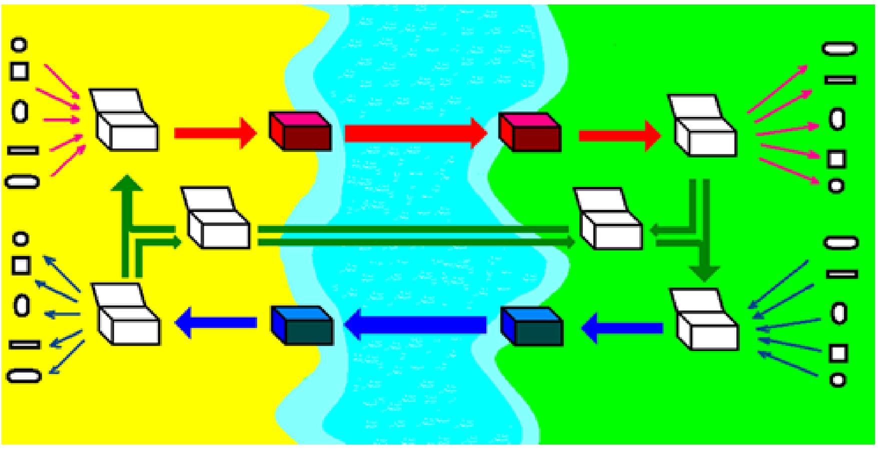


Fig. 5. Imbalanced container trade

From a view of a port, the correspondent cargo flows on the seaside are import of laden containers, export of laden containers, import or export of empty containers – depending of the laden import and export ratio. In early stage of container shipping era, sea lines usually did not let the boxes leave the territory of the port, preferring to stuff and strip them in its boarders, as Fig. 6 shows.

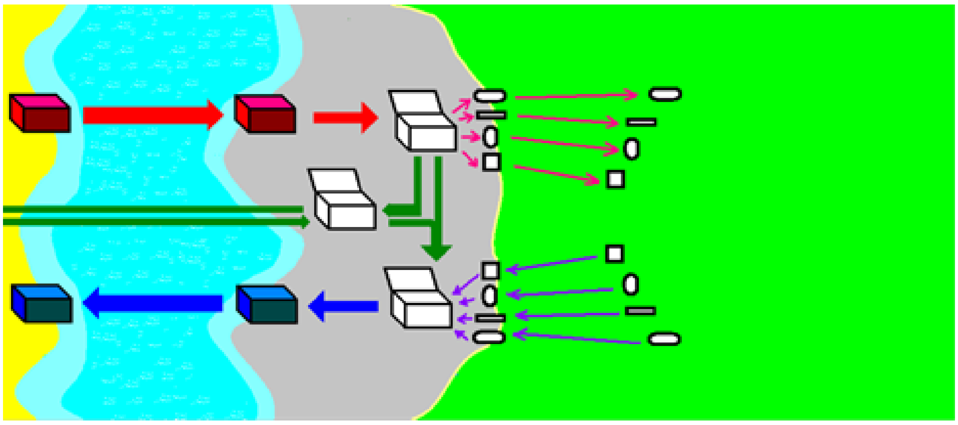


Fig. 6. Principal flows of container port

With the growing perception of the advantages offered by the container transportation, more and more containers started to penetrate the port's hinterland (Fig. 7).

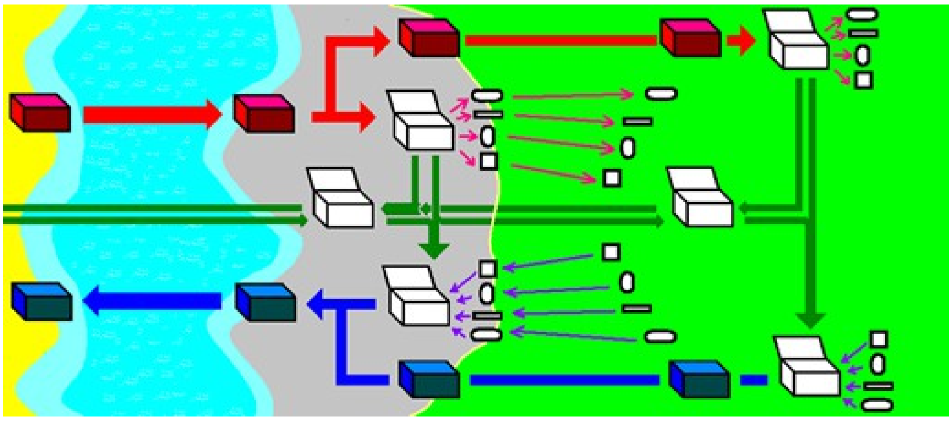


Fig. 7. Sea and land flows of container port

Accordingly, in addition to break bulk flows in and out of the port, more and more containers followed the trajectories "box in – box out" through the port. Soon these flows were supplemented with the transshipment flows, as a result of sea routes rationalization caused by permanent ship size growth.

A general model of cargo flows of a container terminal is represented by Fig. 8.

This model is a functional system: its elements are container handling and general cargo fronts – sea, track, rail, import, export and transshipment container yards (CY), import and export inspection sites, container freight station (CFS) for import and export cargo; its ties (links) are inner cargo flows passing from element to element in accordance with their destination.

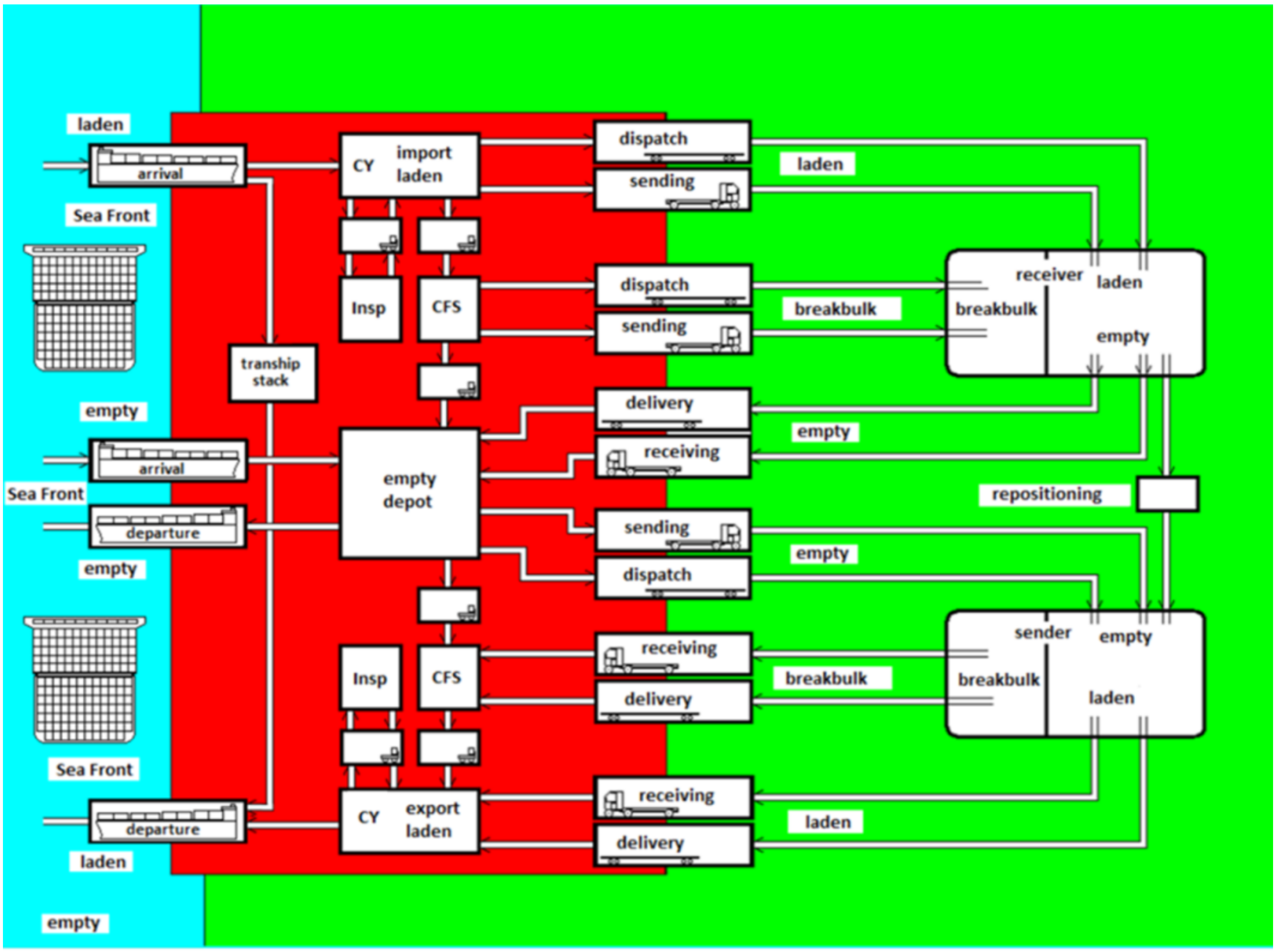


Fig. 8. General functional model of container terminal

This is also an universal model in that sense that by stretching out some links it is possible to receive any functional model of a concrete terminal. Some examples of these sub-set terminals are represented by Fig. 9–11.

Fig. 8–11present some detailization of the general concepts given by Fig. 3–7 in the sense of logistic flows passing over the container terminal. The physical structure of a terminal could be different, with CFS import and export section usually (and CY frequently) combined in one facility, as schematically shown by Fig. 12.

While the images on Fig.1 and 12 are overloaded with small unimportant details, the Fig. 3–10 could be too laconic for our consideration. For the study of physical (material) components of logistic flows an schematic intermediate picture as on Fig. 13 could be more convenient.

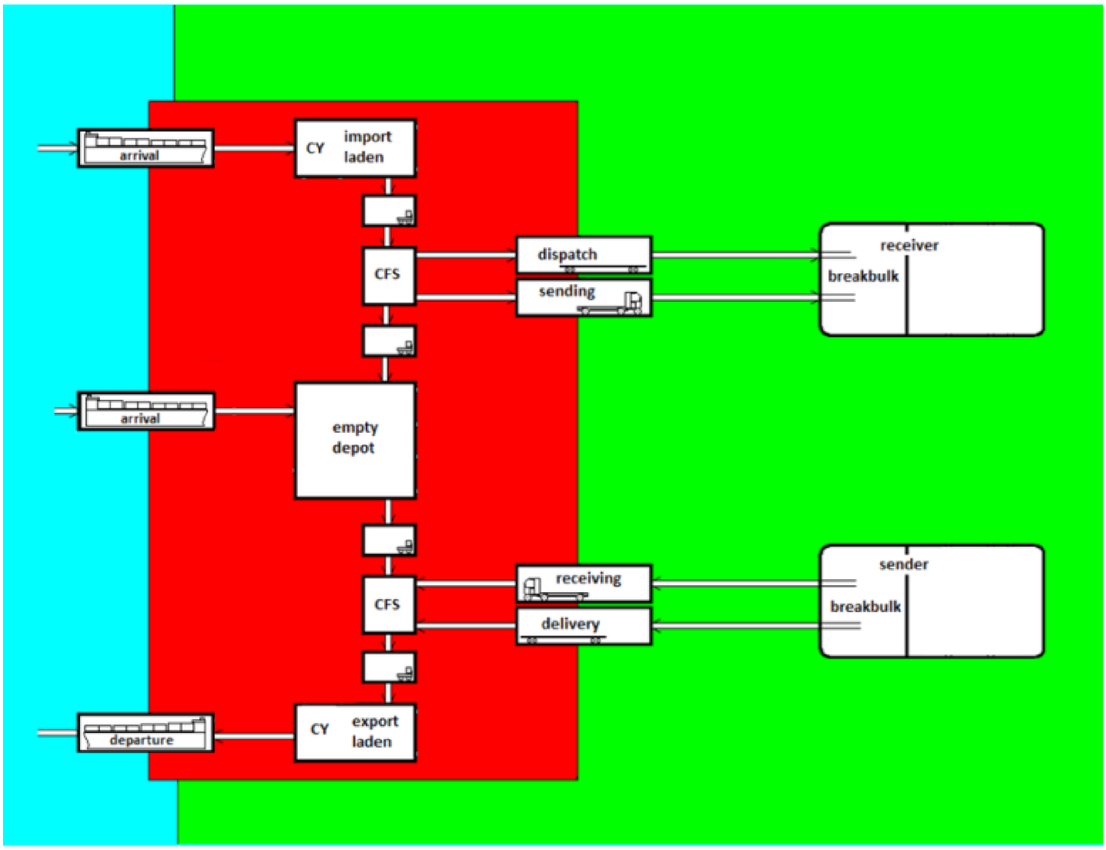


Fig. 9. Conventional terminal with prevailing export function (empty container acceptor)

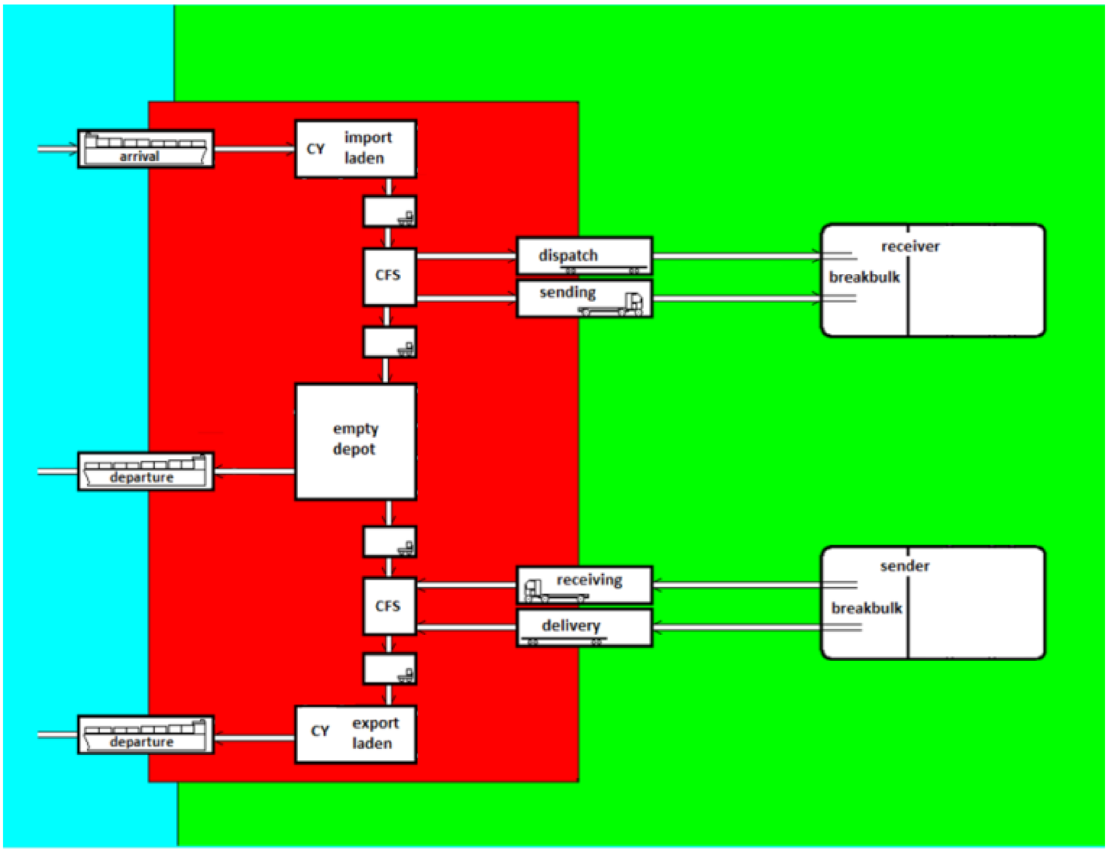


Fig. 10. Conventional terminal with prevailing import function (empty container donor)

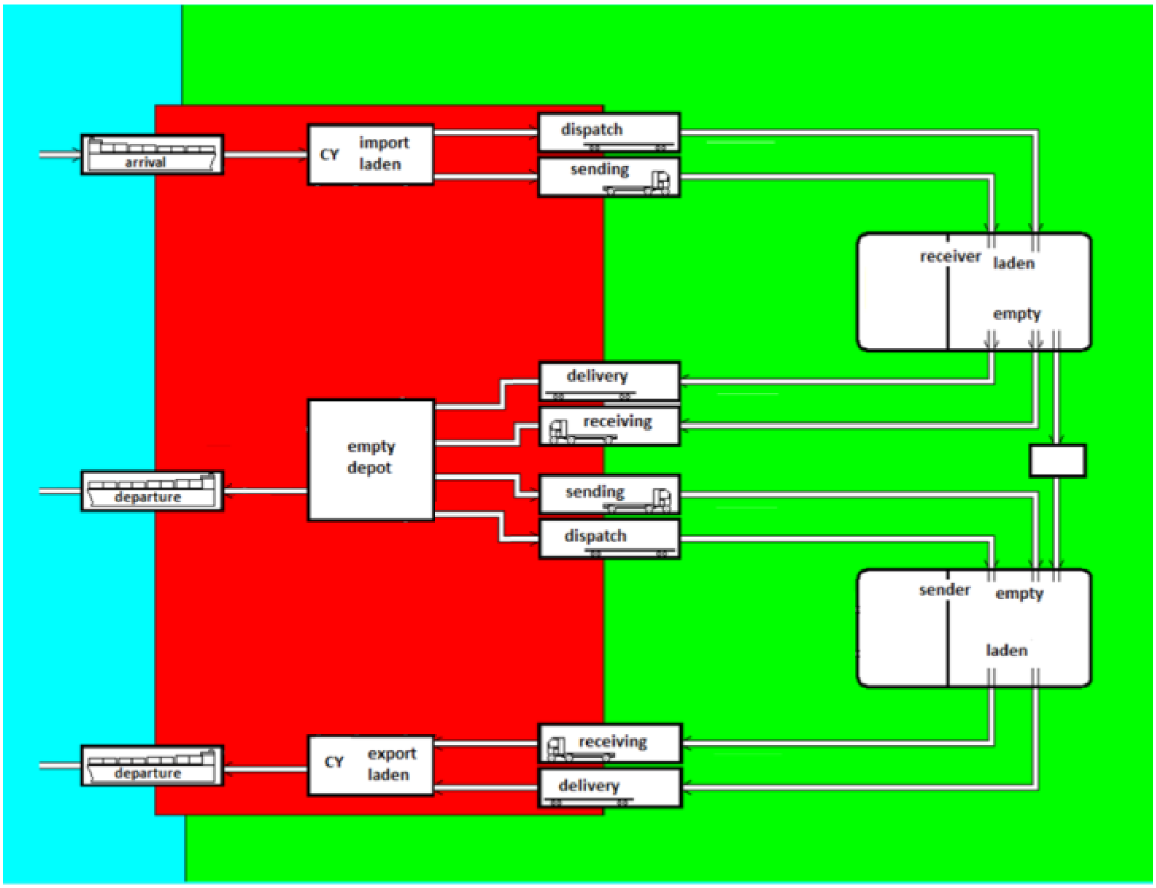


Fig. 11. Box in/Box out terminal with prevailing import function (empty container donor)

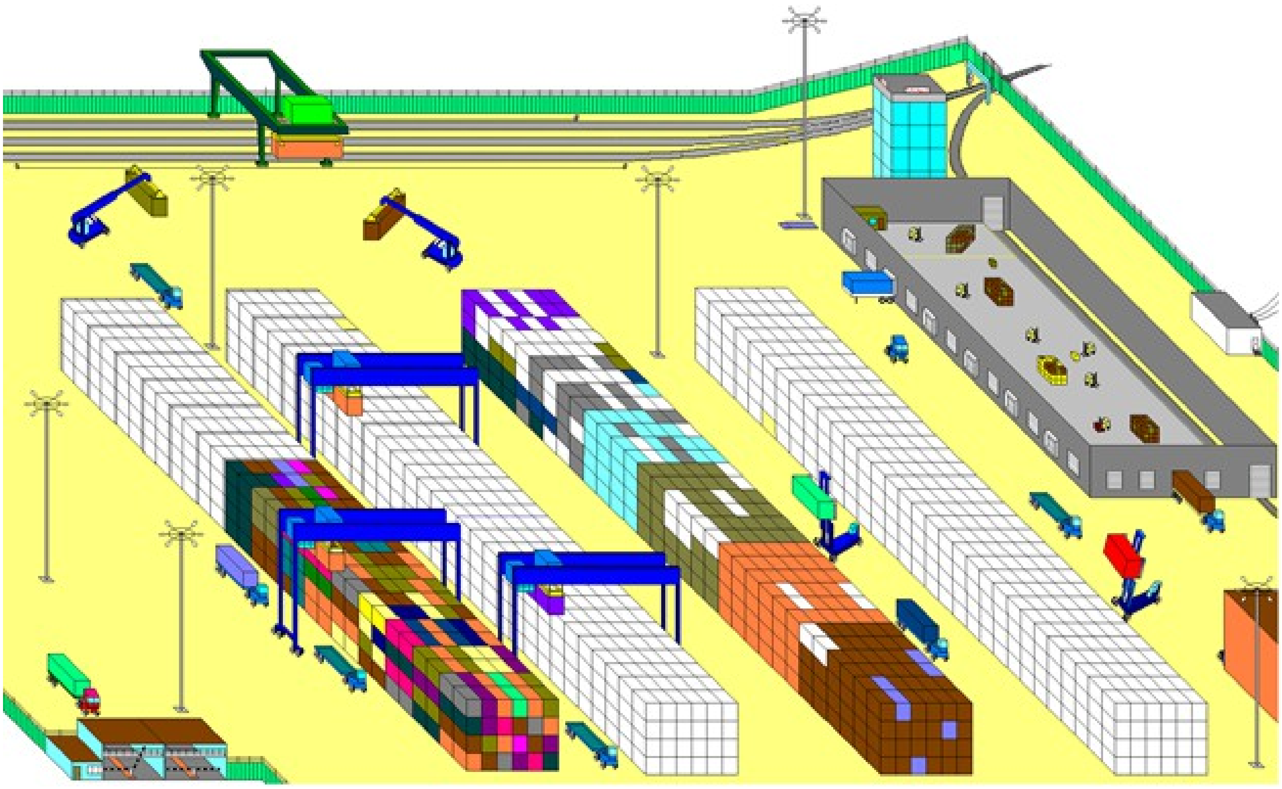


Fig. 12. General outlook of container terminal

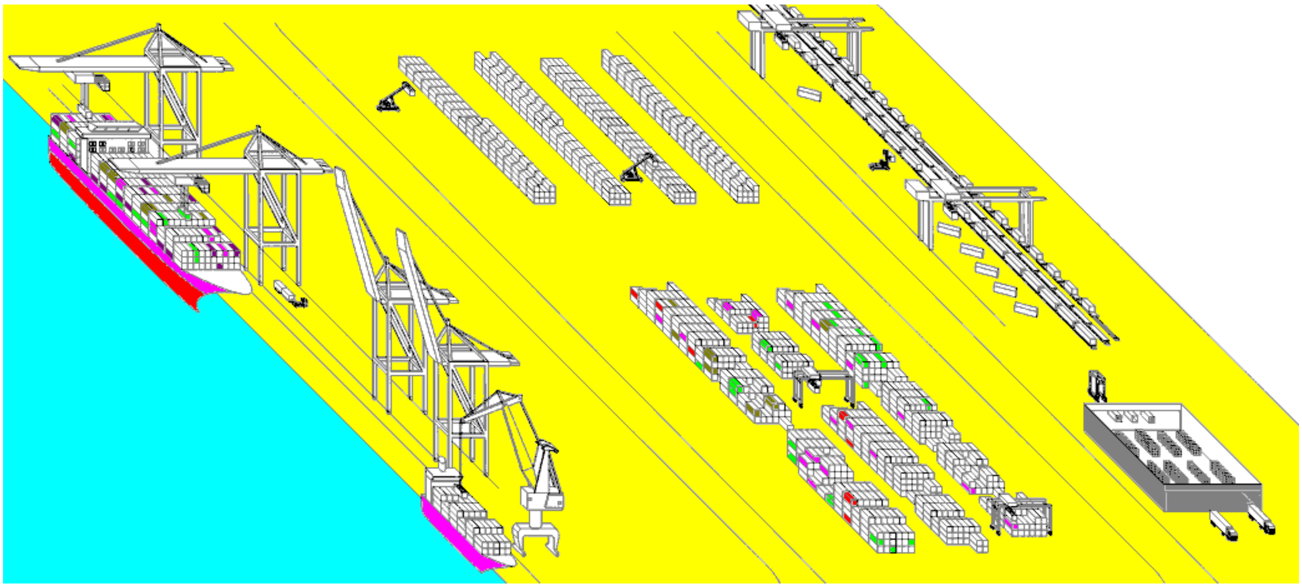


Fig. 13. Schematic diagram of container terminal

Main functional element of the model given by Fig. 8 in this representation are mapped on Fig. 14.

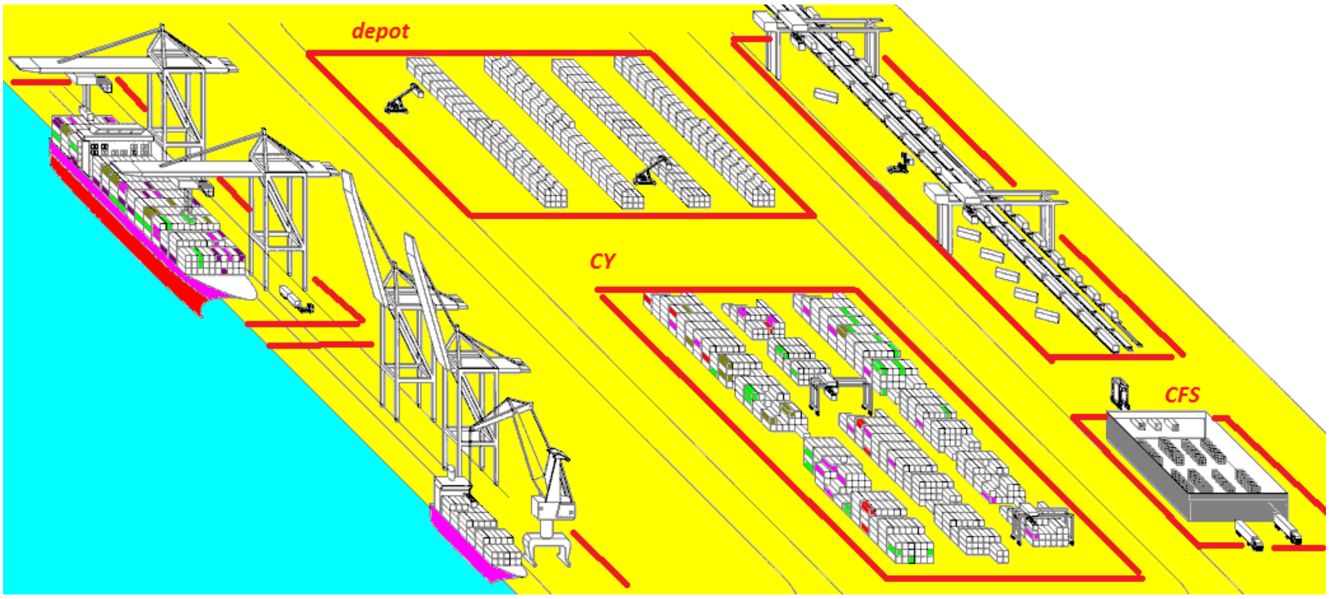


Fig. 14. Interpretation on the general model

This model could be used as a blank form to fill it with the concrete transportation trajectories of cargo on its way passing the terminal. Still, the presentation of terminal given by the model on Fig. 8 is much more useful for technological calculations. For example, Fig. 15 gives a sample of the model used for assessment of transportation works and rate of operation in different links.

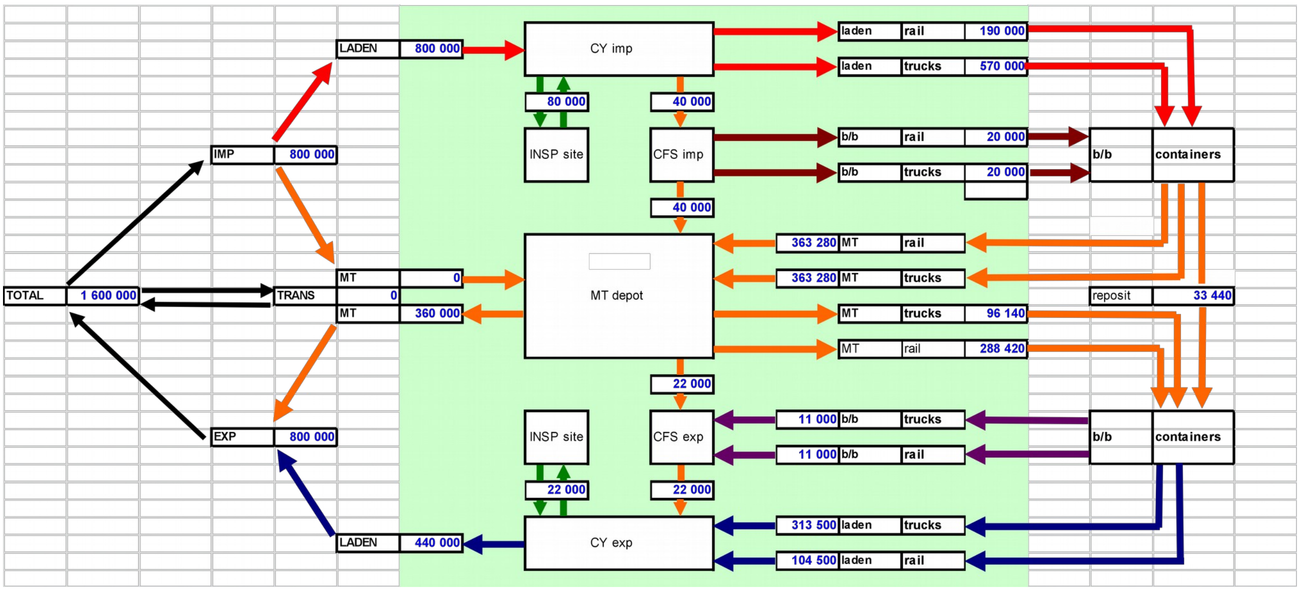


Fig. 15. Model of annual transportation flows

Terminal cargo handling system

The spectrum of equipment used for container handling on container terminals is rather wide [8], as Fig. 16 shows.

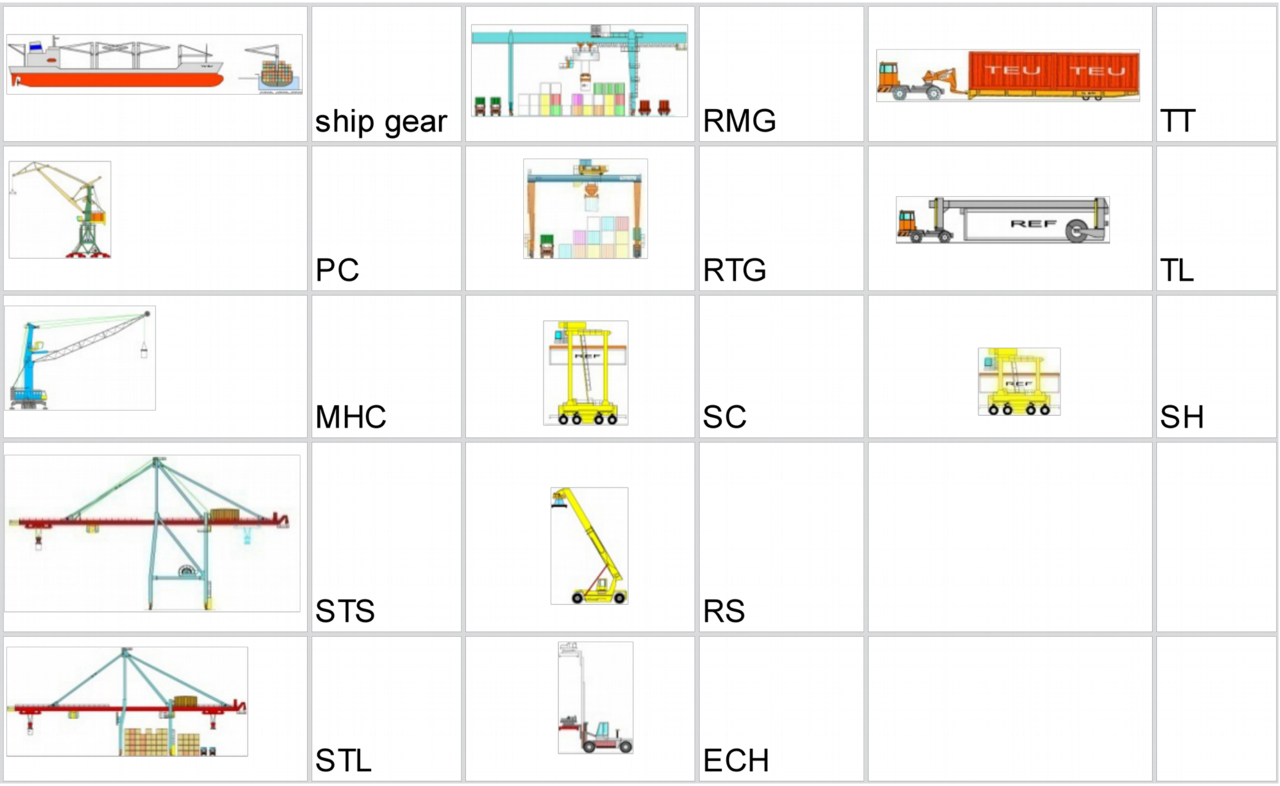


Fig. 16. Equipment for container handling on sea terminals

This equipment supports all operations needed for cargo flows passing along every link shown by Fig. 8. This operations could be break into five universal primal moves, as shown by Fig. 17 for one such a link.

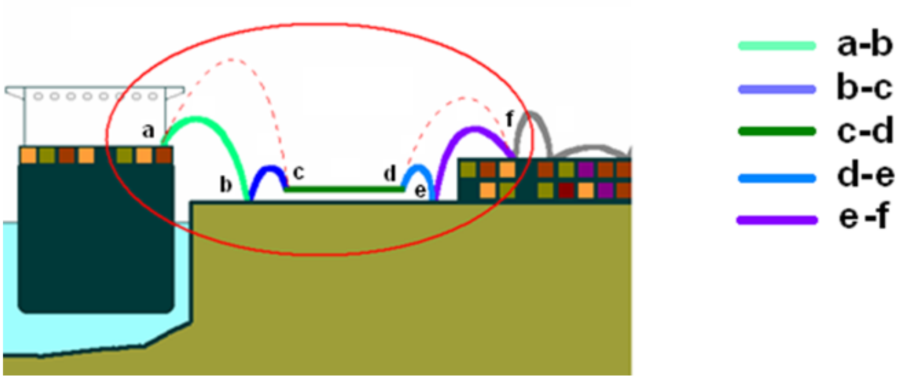


Fig. 17. Transportation Sea-CY broken into primary moves

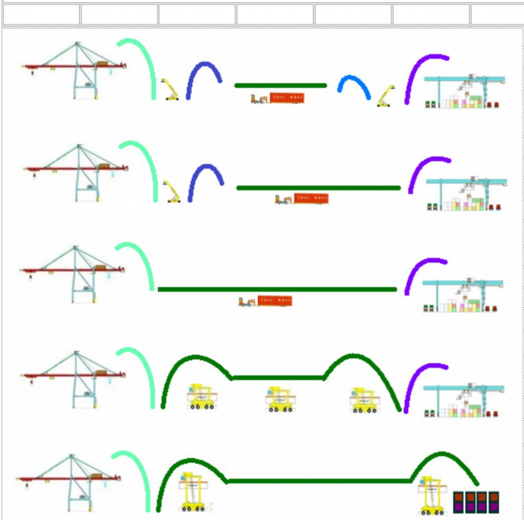
A box should be:

- picked up from initial (point *a*) and placed on the surface (*b*);
- picked from the surface (*b*) and placed on a ground transportation vehicle (*c*);
- delivered(from *c*) to a designated location (*d*);
- picked from the vehicle (point *d*) and placed on the surface (*e*);
- picked from the surface (*e*) and placed on the final location(*f*).

In some cases two or more primal moves can be executed by the same machines. Usually the allocation on the ground is typical for so-called decoupled operations, which minimize the idle time of the pieces of equipment waiting for the neighbor's "hand shake".

Using the pre-defined codes for all types of equipment, it is possible to map every link, as Fig. 19 displays.

SAMPLES OF OPERATION DESCRIPTION



ab	bc	cd	de	ef	
STS	RS	TT	RS	RMG	Heterogeneous RTG handling system
STS	RS	TT	RMG	RMG	Heterogeneous RTG handling system
STS	STS	TT	RMG	RMG	Heterogeneous RTG handling system
STS	SH	SH	SH	RMG	Heterogeneous RTG handling system
STS	SC	SC	SC	SC	Homogeneus SC handling system

Equipment codes to use in operation descriptions

STS	RMG	RTG	SC	RS	SH	ECH	TT	TL	rRMG

Fig. 19. Samples of different implementation of Sea-CY link description

The process of mapping is illustrated by Fig. 20 for some inner transportation links of the general model.

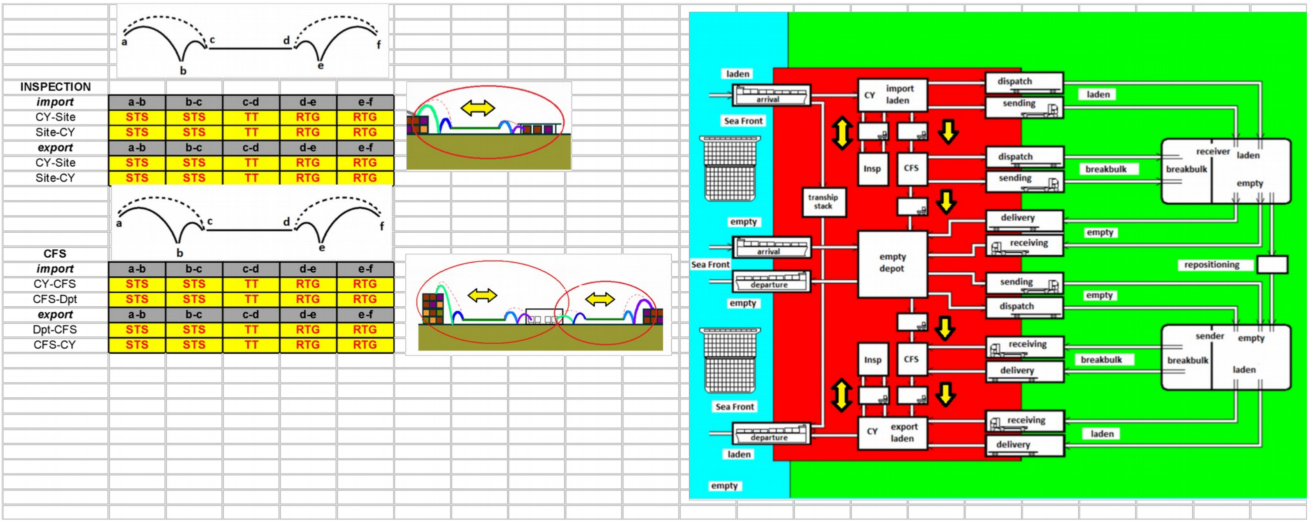


Fig. 20. Inner terminal links description

These blank forms enable to build the technological model of the container terminal under design (Fig. 21).

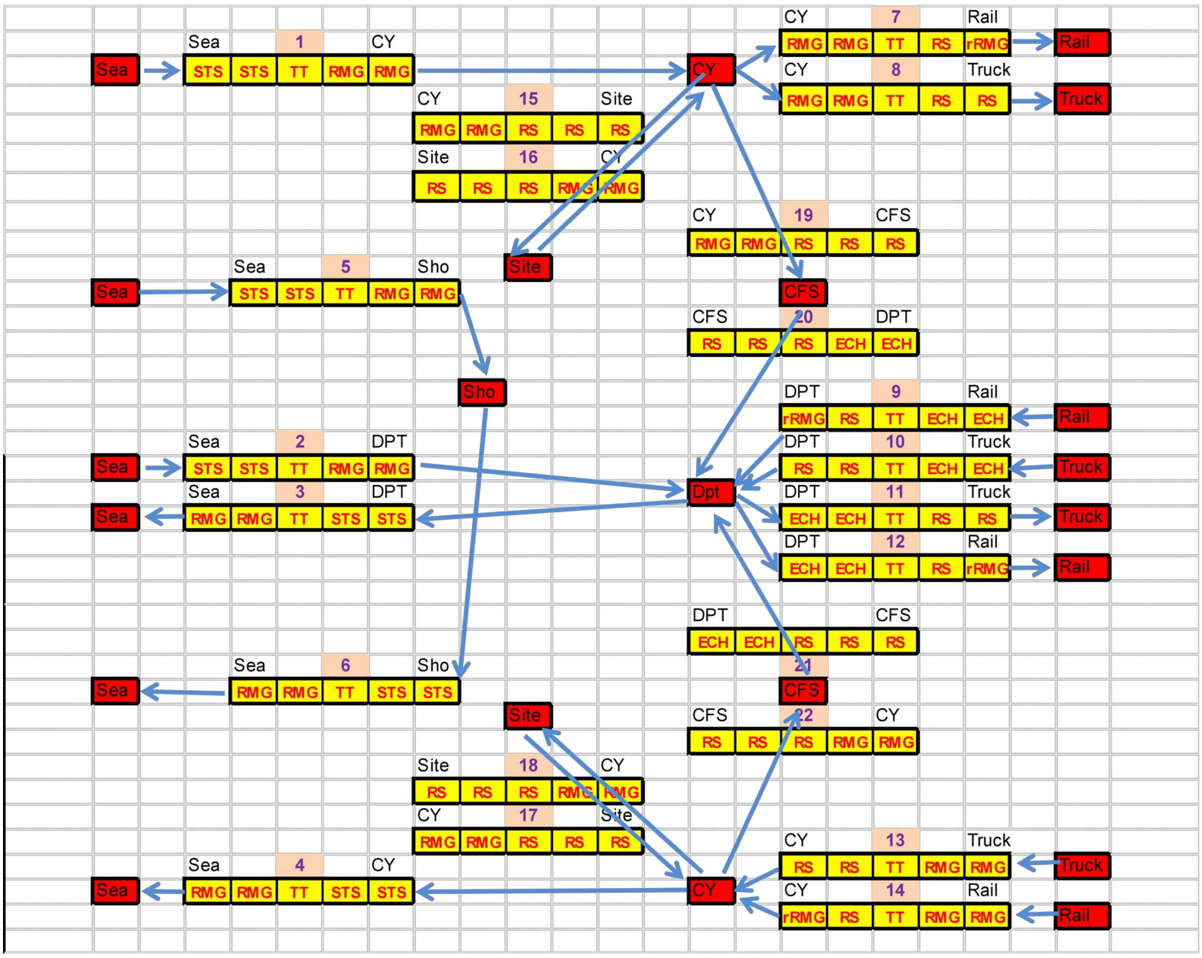


Fig. 21. Technological model of the terminal

The container terminal flow specification (Fig. 15) contains the required number of moves at every link, while the technological model on Fig 21 specifies the equipment used for these operations.

Eventually, the information accumulated at this stage enables to generate the matrix of equipment engaged into operations in every link. The knowledge of the amount of annual moves at every link (transformed from TEUs to boxes with the use of TEU-factor) enables to calculate the total working hours for every type of equipment engaged into operations at the designed terminal. Technical rate utilization and average occupation for the equipment enables to assess the demands for every type of the equipment assumed to use on the terminal.

Conclusions

1. The paper introduces a formal model of container terminals.
2. The approach is based on a general model of logistic flows passing the container terminal.
3. The model offers a natural classification of different container terminal types.
4. The model enables to identify and study material components of logistic flows passing the container terminal.
5. Different cargo handling system could be easily introduced in the model.

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CLASSIFICATION AND FUNCTIONAL MODEL OF ECHELONED CONTAINER TERMINAL SYSTEM

The article deals with functional features of different types of container terminals. It is shown that in the course of development seaports changed from material handling points to distribution centers, from just sea-land interface to key objects of cargo conducting network covering all hinterland. The functional models of these elements are presented, along with the classification of container terminals, as elements of an advanced container transport-technological system consisting of several echelons. The role of this approach in design and development of container terminals is discussed.

Key words: *container terminal, container yard, classification, functional model, container echeloned transport-technological system*

Evolutional drivers of the study

The evolution of the sea trade ports during the last decades showed an explosive instability of their development, reflected in cardinal transformation of their structure, both technological and functional. Modern port not only transformed from simple loading-unloading stations into global and regional distribution centers, but also changed their geopolitical status – from point objects into network structures. Today sea ports successfully cooperate with hinterland terminals and container yards, building up jointly an integrated echeloned cargo-conducting system.

The ways of port development after 1970-th was the object of many scientific studies. Quite naturally, one of the first step of those study was classification. Indeed, the assignment of a terminal to a certain class provides a possibility to predict the direction and perspective of its development, define the character and reasonability of the investments [1–3]. Simultaneously, in this historical period the general port structure started to enhance its functionality and develop new hinterland elements, among other sequences resulting into modern 'dry port' concept.

This is clearly seen by comparison of previous and current port/terminal classification in international professional literature [4–6].

Consequently, for prognostic purposes it is necessary to study the developing functional ties between echeloned terminals operating in the integrated logistic environment and develop an adequate classification. The object of this study is container terminals, since specifically container cargo flows are widely differentiated by cargo owners.

Container terminal classification by logistic signs

The modern transport logistics, after long discussions and arguments, mauled the classification including only three categories of terminals [3, 5–8] shown by Fig. 1.

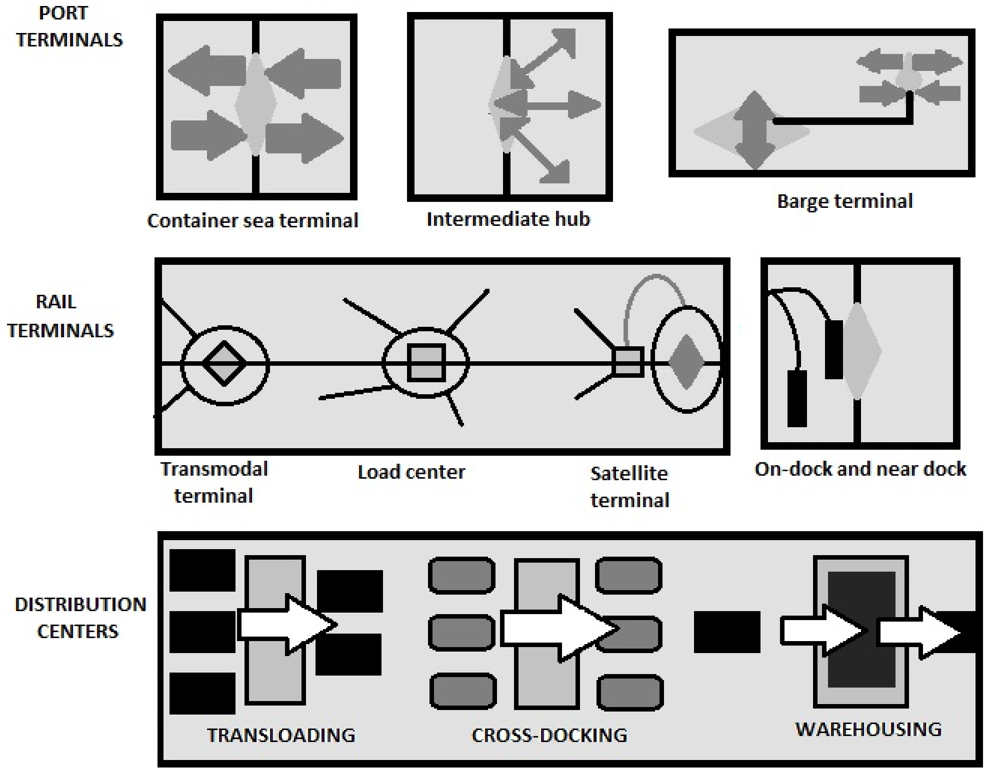

Fig. 1. Types of logistic terminals

As one can see, the modern transport logistics suggests distinguishing the following types of container terminals:

- Sea terminals (performing transit and transshipment operations, connecting the sea routes with inner waterways);
- Rail terminals: the railheads of sea terminals, satellite terminals; load centers; trans-modal terminals;
- Distribution centers (for trans-loading, cross-docking and warehousing).

For the sake of unification and standardization of technological decisions required on the different terminals, it is necessary to develop the relevant classification based on technological signs: type of cargo and connected transport modes [9–12]. It looks reasonable from this point of view to identify the cargo flows which connect all these terminal into a single network entity. Based upon this consideration, the technological (cargo-handling) models could be selected, which would form a basis for the classification we looking for.

Container terminal classification by technological features

Functional model of sea container terminal

Fig. 2 displays the main directions of cargo flows and specification of container handling operations performed by the sea container terminal.

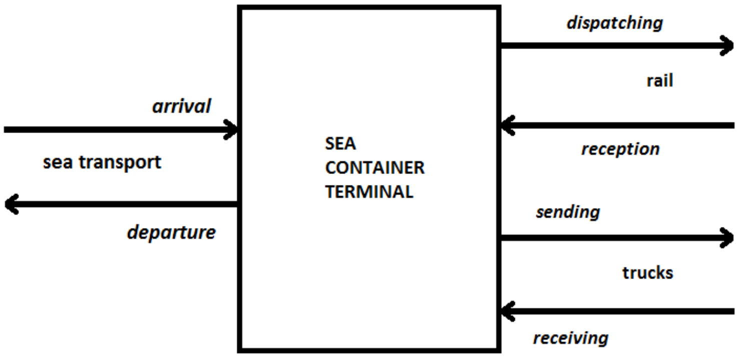

Fig. 2. Operations of the sea container terminal

The import direction is represented by cargo arrival by sea transport; the export – by cargo departure with this mode. The import containers and general cargos are dispatched by rail and sent by trucks. The export containers and general cargos are receipt by rail or received by trucks.

The trajectories of containers and general cargos passing the terminal form the functional schema of the container terminal with connection to its hinterland (Fig. 3).

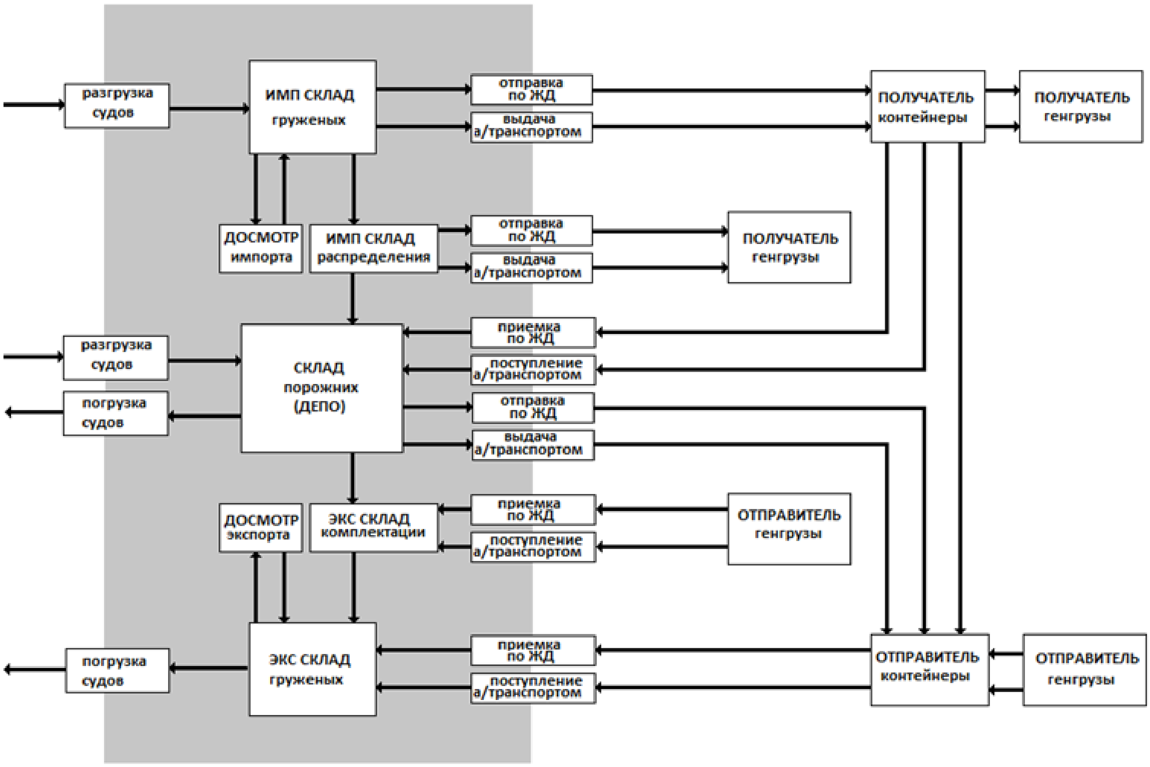

Fig. 3. The model of the sea container terminal and its interaction with hinterland

The grayish rectangular in the left-hand side of the figure encloses the functional model of the sea container terminal; the right-hand side shows its interaction with the hinterland. This format will be used for representation of all the objects under the study.

The import containers are unloaded from the arrived ships through the berth and placed on the import container yard. A certain share of these containers is transported to the inspection site and returned back upon its completion. Some containers leave the container yard laden, through rail or truck cargo fronts. The other share is stripped at the import container freight station (CFS), with empty containers brought to the empty container depot. The generated (stripped from laden containers) break bulk cargo leave the terminal dispatched by rail or sent by trucks.

The laden container delivered to the end customer (the receiver) is stripped and returned back empty by rail or truck to the terminal (specifically, to the depot). Some of the empty containers could be repositioned directly to a sender in a hinterland location, thus saving the returning to the terminal and sending for stuffing in the hinterland location of senders. The possible shortage of the empty containers for export cargo is covered by delivery from the depot by rail of trucks.

The laden export containers arrive at the terminal sending by trucks or received by rail from the cargo shippers in the hinterland. They are placed on the export container yard. The container yard also accommodates laden containers after stuffing with export break bulk cargo at the export CFS. After inspection of some share of these containers, they are loaded onboard ships leaving the terminal.

Depending of the functional destination of a terminal, the shares of the transformed cargo flows' volumes could be different. For example, the zero level of containers passing through the CFS turns the terminal into a pure "box-in/box-out" terminal. The zero amount of container leaving and arriving by land will make the classical sea container terminal of the end of XX century, when the containers of shipping lines where stuffed and stripped within the port boundaries. The zero level of land cargo flows, break bulk or laden containers, shapes the terminal into a classical empty container depot.

It should be stressed here that a typical container terminal's operating conditions assume the balance of import and export volumes of cargo handled through the berth. The ship operators prefer to carry away the same average amount of containers from the port that they brought to it, empty or laden. This is achieved by the efforts of forwarding companies as well as by offering attractive tariffs for empty container repositioning, frequently included into the cost of the direct transportation.

Functional model of hinterland container terminal

In case of the hinterland container terminal the role of the import and export flows is played by the land transportation delivering containers between sea and land terminals (Fig. 4).

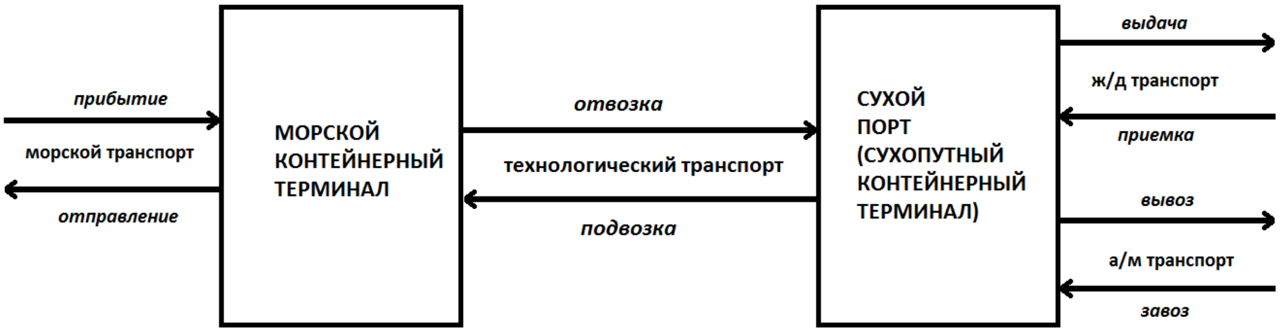

Fig. 4. Interaction of sea and hinterland terminals

The correspondent functional scheme of this interaction is represented by Fig. 5.

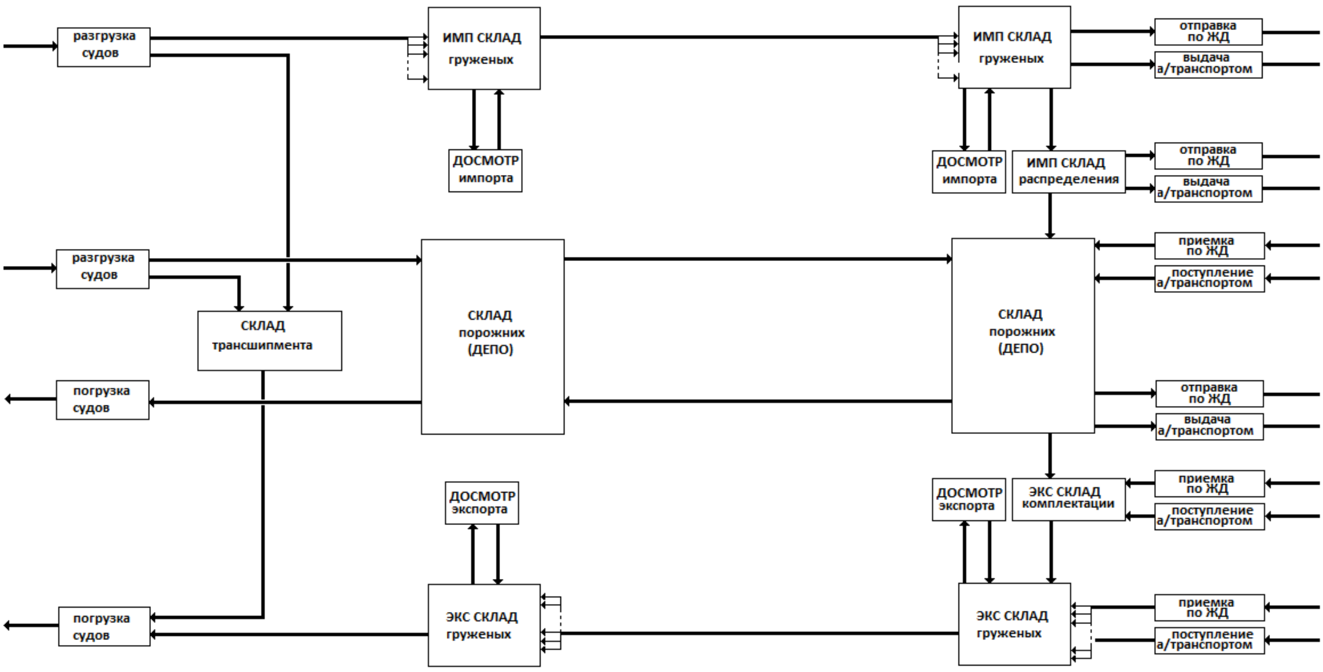

Fig. 5. Functional model of sea and land terminals' interaction

Usually, the presence of the CFS (designated for transformation break bulk into containerized cargo and back) is mandatory. Comparison of the functional schema of sea and land terminals (Fig. 2 and 4) shows that the CFS designation and connections with the rest elements of the terminal remain the same. Nevertheless, in addition to common functional features, there appear significant practical differences that should be taken into account in designing, planning, operation and development management of the terminals.

The functional model of the land container terminal is given by Fig. 6.

Functional model of industrial container terminal

In any ways the containerized cargo eventually arrive the end customer for stripping (transformed from containerized to break bulk cargoes). Respectively, at the industrial plants manufactured goods are staffed into containers (transformed from break bulk to containerized cargo). These operations are performed at relatively smaller industrial terminals, which are illustrated by Fig. 7.

Similar to sea and hinterland terminals, the industrial terminal has its own functional structure shown by Fig. 8.

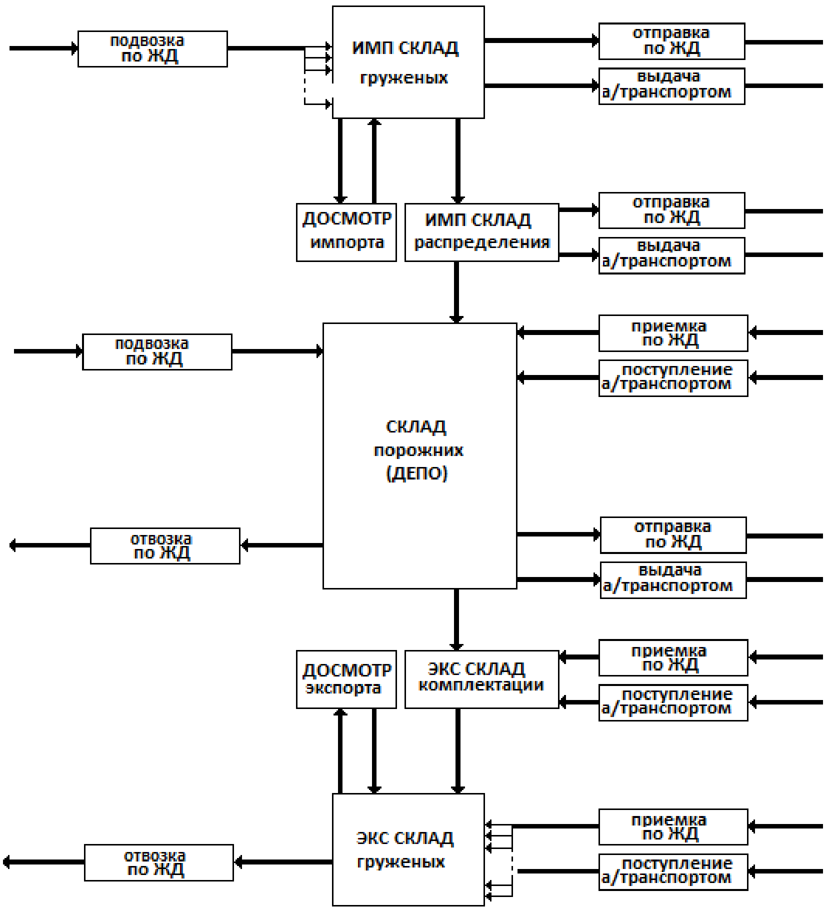

Fig. 6 Functional model of land terminal

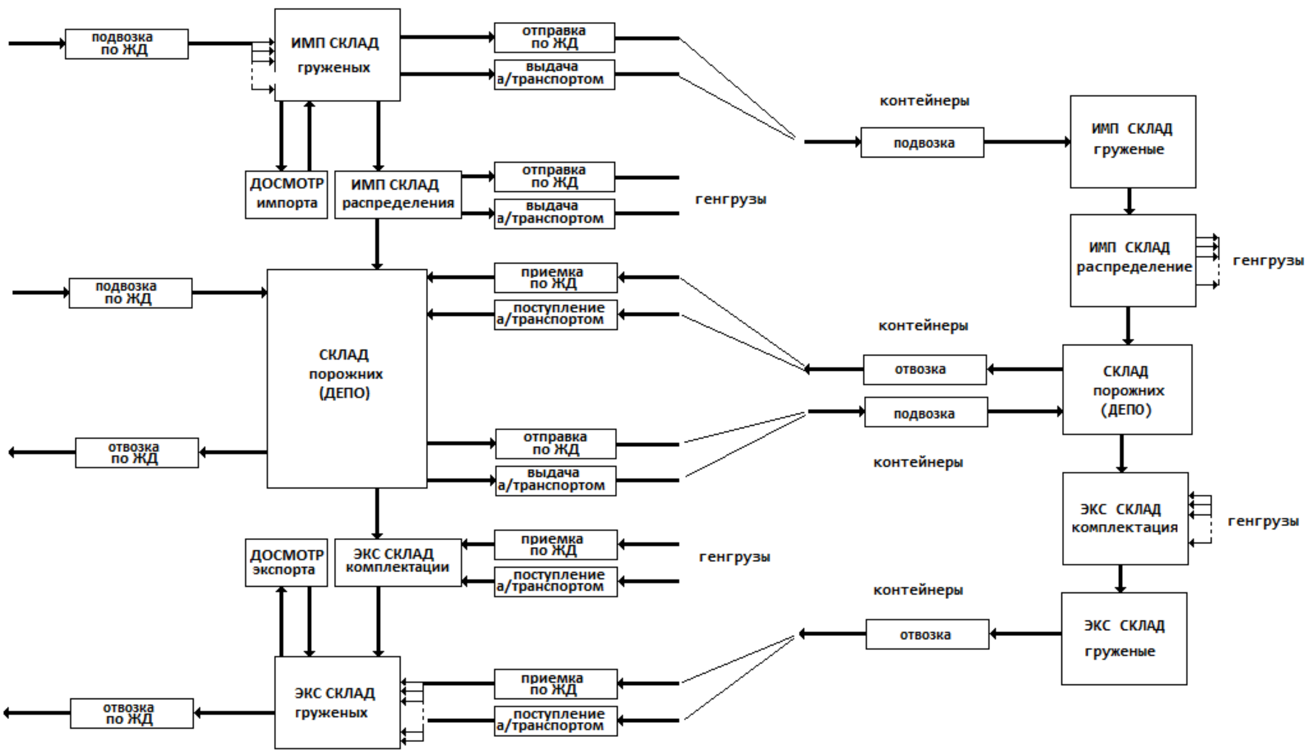

Fig. 7. Functional model of land and industrial terminals' interaction

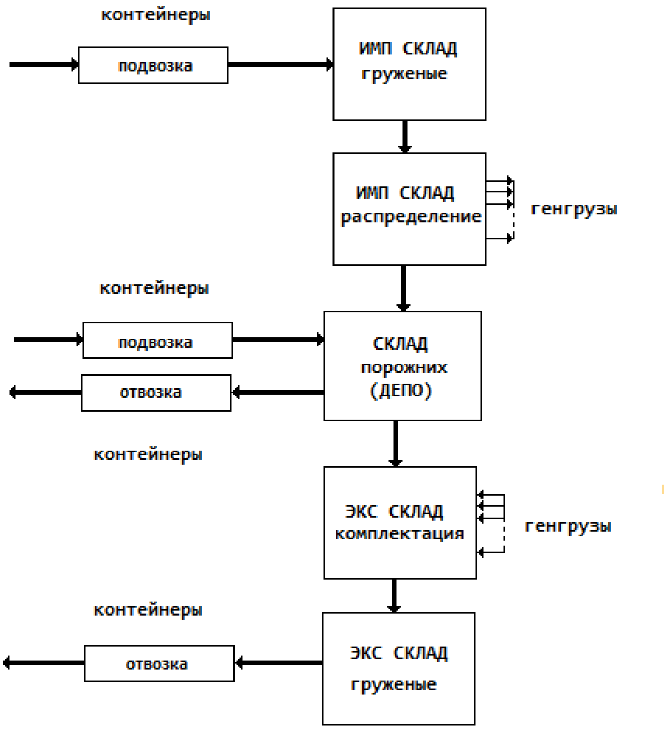

Fig. 8. Functional model of industrial terminal

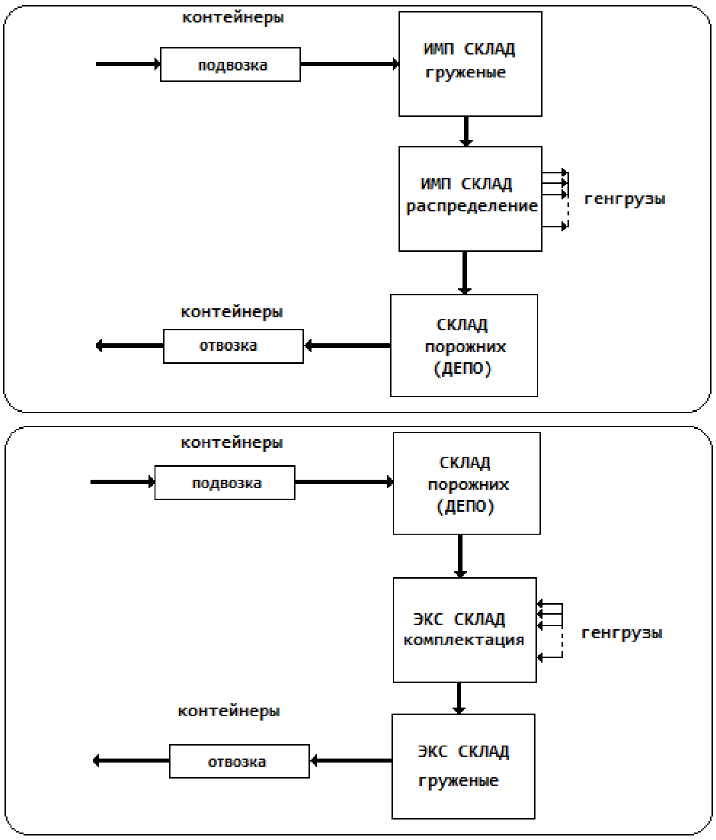

Fig. 9. Functional models of pure import and pure export industrial terminals

This figure shows both the import industrial terminal (accepting the containerized cargo and transforming it into break bulk) and export industrial terminal (consolidating break bulk cargoes and transforming it into containerized cargo). In more common cases of only export or only import industrial terminals they perform a limited set of operation, which is displayed by Fig. 9.

Feeding the industrial terminal with containers could be done by different modes: rail, truck, barge transports, thus inducing specific features of main elements' configuration – cargo fronts, equipment, connecting rail tracks, roads, yards, warehouses and sheds (Fig. 10).

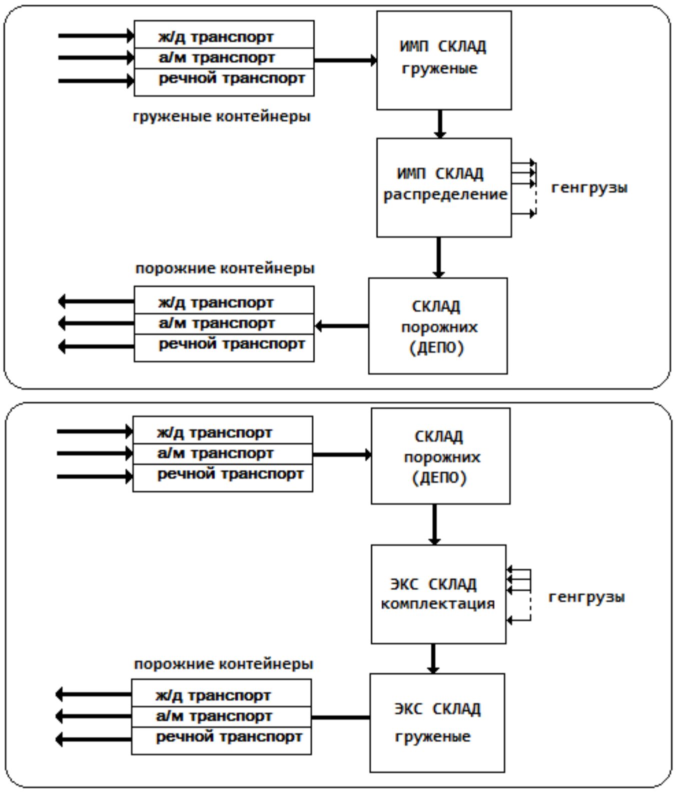

Fig. 120. Terminal elements' differentiation by modes

Functional model of industrial container port

The transport/logistics schema and functional models studied above referred to advanced supply chains. In the same time, an industrial terminal could be connected directly to the foreland sea routes, when distribution centers are close to the shore line or industrial zones are located on the sea port territory. In this specific case the industrial terminal takes a status of industrial port in its conventional interpretation [13–15], which is illustrated by Fig. 11.

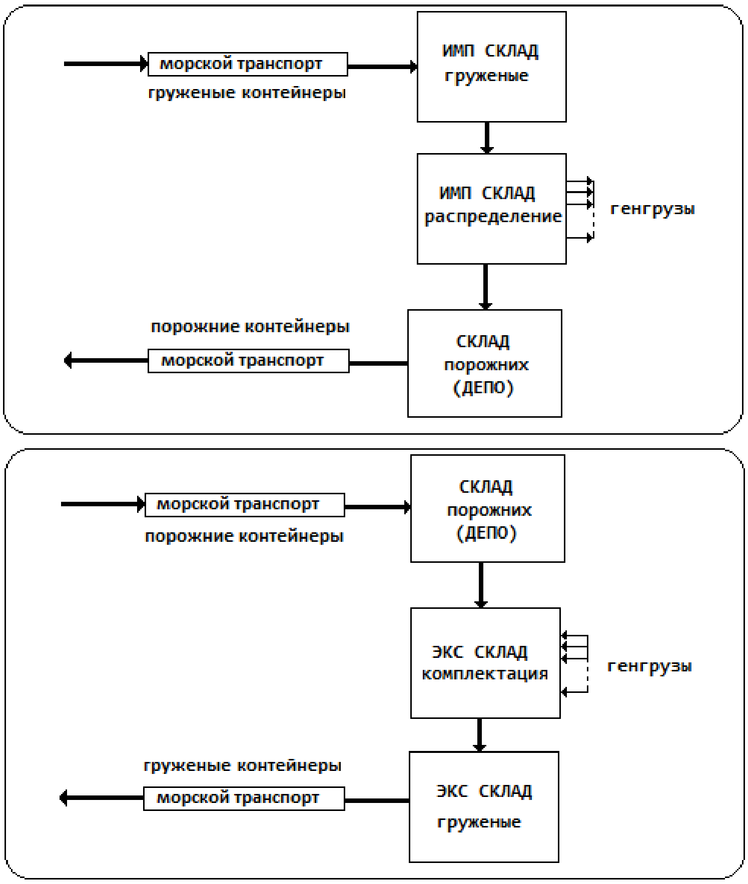

Fig. 131. Functional models of industrial container port

Conclusions

In the first head, the study enables to identify distinguishing functional features of container terminals of different types, in the same time preserving their technological unity.

This circumstance, from one hand, enables to speak of the existence and development of unified (global) echeloned container transportation system as a basic infrastructure for cargo conduction. Accordingly, any single transport processes in any R&D and development procedures should be treated systematically, that is in their interconnection and interdependency.

Consequently, the classification of container terminals introduced in this paper defines these objects as sub-systems. This approach enables to take into account all functional ties and connections. In its turn, this enables to make any required forecasts, planning and assessments of possible development of separated infrastructural elements.

On the other hand, the introduced approach does not permit to regard any terminals as relatively separated objects. Any R&D activities, feasibility studies, project and development could be misleading without taking into account these aspects and factors.

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FEATURES AND PRIMARY BENEFITS OF USING THE NUCLEAR LIGHTER CARRIER - CONTAINER SHIP «SEVMORPUT» IN THE ARCTIC

The article describes the nuclear lighter carrier – container ship «SEVMORPUT», a unique phenomenon in the history of the world fleet. The history of the vessel, its main technical characteristics, objectives and operating conditions are discussed. Much attention is given to the recent ship upgrade and its results. The analysis of the operating conditions of the vessel in the Arctic Area and its purpose brings a clear understanding of its peculiarity.

***Key words:** lighter ship, nuclear lighter ship, lighter carrier – container ship, «SEVMORPUT»*

Lighter ship is a type of sea-going vessel, which has focused specialization and designed to carry one or more particular types of cargo [2].

Lighter is a barge intended for the carriage of cargoes by means of tugboats as well as for cargo operations on the road [2].

Types of lighterage systems differ from each other in that the main dimensions of lighter correspond to the dimensions of the river barge in serviced areas. On Average, the lighter length accounts for 1/4 or 1/2 of the length of river barge.

Modern lighter are divided into two groups: ocean lighter and feeder lighter. Ocean lighter is intended for transportation between big ports in different regions, while feeder lighter between small ports within one region [8].

There are three ways of loading and unloading:

- By lifting to the level of a certain cargo deck by a synchro-lift
- By lifting by a gantry crane and install the lighter in the appropriate box on the ship
- float on/float off

Types of lighter ships in use:

- Lighter aboard ship
- Sea Bee
- Barge Container
- Barge aboard catamaran
- Feeder lash [3]

Today in Russia there are ten civilian ships with a nuclear power plants. Nine of them are nuclear icebreakers and one – the nuclear lighter carrier – container ship «SEVMORPUT». This is the largest fleet of civil nuclear ships in the world. «SEVMORPUT» is equipped with a main hull, able to move independently on field ice up to one meter thick. Its reactor cooling system differs from systems in the other nuclear-powered ships. It does not require seawater with low temperature. For this reason, «SEVMORPUT» is able to operate in warmer seas, too [1].

It was Built in Kerch, in the shipyard "Zaliv". «SEVMORPUT» was Laid November 2, 1984, And was put into operation in 1988. The first years of exploitation of lighter ship worked on international line Odessa – Vietnam – Vladivostok and Vladivostok – DPRK. Then a few years later the ship provided cargo traffic on the line Murmansk – Dudinka – Murmansk [1].

In 2008–2013 «SEVMORPUT» was not in operation. At the end of December 2013, the General Director of «Rosatom» Sergey Kiriyenko signed an order for a restoration «SEVMORPUT». On November 30, 2015 after the factory test completion the ship relocated back to Murmansk [7].

Some of the equipment, engineering systems as well as waste water system were replaced, two additional cranes, two diesels and a new board radar were installed, and other innovations were undertaken. The total cost of the new renovation amounted to 57 million rubles.

Scantling numeral [4]

Deadweight, t	33240
Displacement, t	61880
Length overall, m	260.3
Rule length, m	236.6
Beam, m	32.2
Molded breadth, m	30
Height, m	18.3
Draught, m	11.8
Speed	20.5

The vessel is designed for transportation:

- LASH in the holds, in specially equipped cells and on the upper deck using the ship's lighterage crane for loading/discharging;
- International Standard ISO containers in the holds and on the upper deck. The loading/discharging of containers should be realized by shore-based facilities.

Vessel can carry 74 lighters with capacity 300 tons or 1,328 twenty-foot containers.

The ship's cranes are:

- Crane «KONE» with a maximal load capacity of 500 tons;
- Two cranes with a maximal load capacity of carry 16 tons;
- Two cranes with a maximal load capacity of carry 3.2 tons [5].

The nuclear lighter carrier – container ship «SEVMORPUT» will facilitate the Russian troops deploying in the Arctic. The ship can be used to perform various tasks including those coping with interests of the military establishment. As an ice-class vessel, «SEVMORPUT» is capable of carrying cargos of different sizes in terms of the Northern Sea Route [6].

The economic benefits of using the «SEVMORPUT» are undoubtedly high.

There is a southern route through the Suez Canal and a northern route from Murmansk. Train includes approximately 100 wagons. The way from Vladivostok to

Moscow takes from 9 days to 2 weeks. It depends on the line's workload. «SEVMORPUT» is able to accommodate up to 1,400 containers, which accounts for the capacity of 14 railroad trains. The transportation from Murmansk to Vladivostok takes 10–12 days. The route to Kamchatka (Petropavlovsk-Kamchatsky region) is more profitable. The well-being of this region depends on the regular northern supplies. This sea route takes a quarter less time and costs less than half of the price compared to the Vladivostok route. The container line Murmansk – Petropavlovsk-Kamchatsky helps to attract transit cargo traffic. For example, from Europe to Asia and back.

Today, in consequence of the crisis, sanctions and unfavorable investment rating of our country, the speed of the project realization has slowed down. However, the government is interested in its completion. «SEVMORPUT» carries vital supplies to remote villages, cities of the Far North and the Far East regions of our country. The vessel is important for the development of the North Sea Route, the Far East region and Siberia, as for the military, research and commercial applications.

However, 2015 showed that even if the ice was all gone and icebreakers were useless, the number of ships would not grow. In 2015 only 18 ships have used the Northern Sea Route. It should be developed in terms of infrastructure and popularization. "The Northern Sea Route is the exotica", – said the analyst Michail Ganelin. Especially now, when the freight rates are at historic lows for shippers is easier to use waste routes [9].

The Russian Federation is in a state of crisis. Cargo turnover with the European countries is significantly reduced, hence active collaboration with the European partners is not expected. These plans should be put on a back burner. The inability of European companies to use the newly proposed route to Asia as expected should also be taken into consideration. Therefore, «SEVMORPUT» can be used only for the needs of the Russian economy in the nearest future.

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MODERN PROBLEMS OF TRANSPORT CONGESTION ON THE ROADS AND STREETS OF THE CITY OF ST. PETERSBURG

Considered the implications of the congestion of street vehicular traffic and the ways to solve problems of traffic organization in the modern metropolis. Evaluated the construction of highways over railroad routes in St. Petersburg.

Key words: *vehicles, traffic, highway, transport system*

Nowadays traffic jams became one of the most important problems. Negative effect of traffic jams contains a huge list of problems to solve, to normalize transport system of Saint-Petersburg.

1) *Ecological danger in the city*

The highest pollution in any megapolis is made from engine of any car, bus or train. Average percentage of polluting substances made by transport in Russia is nearly 43 %. 10 % of them are 'climate' gases, 2 % – industry waste, 3 % – wastewater, 5 % – ozone destruction [2].

Vehicles in Saint-Petersburg takes a part nearly 85–90 % in pollution of the city. Passenger transportation makes the largest percentage of damage (up to 60 %) [1].

Any car got multiplicative effect on environment of megapolis. Particularly, interesting fact was watched: the road will get more damage, if cars will ride faster, but when cars will slow down, exhausting harmful gases immediately increases. That's why we got so much harmful gases in traffic jams [1].

2) *Emergency services difficulties*

Information from ambulance of Saint-Petersburg, says that traffic jams on the roads increase the time of arrival, especially in the city center, where the time of arrival should be less in twice. Factual arrival time to a sick citizen goes up to 1,5–2 hours, that makes real danger to the health of a patient [4]. Emergency services hope that a special line on the road should solve that problem. Such lines should be used only by emergency services with turned on special signal.

3) *Traffic jams causes stress*

Traffic jams makes less productivity for working people. Foreign investigations shows that time which was used to get for a job shouldn't be more than 40 minutes. The highest critical point is 72 minutes. If an employee has to waste more time to do that, it will make harm to him and his authority. Long-time way to the office decreases productivity of work in 30% during the first working hour and 10 % less during every next hour [3].

World experience in combating against traffic jams is pretty various. For example in Shanghai problems with traffic jams were sold very simple: all license plates can be bought only using auction. Where prices are nearly 15,000–20,000$. Owing to huge prices, personal transport in Shanghai stays privilege only for rich people, average citizens usually use bicycle. The same way to control transport number is used in Beijing.

In Stockholm after 9 month of testing and referendum was decided to make a paid enter to the city center. Price to enter or exit the center depends on daytime and varies from 1 up to 2 €. At first paid enter was tested in trial version. After that more than half of Swedes agreed to make it paid. They should pay only during weekdays from 6:30 to 18:30. At evening, at night and at weekends it's free to enter and exit. The amount during one day can't be more than 6 €. At the same time Swedish government actively developing public transport [3].

"Driver pays for everything" – the main principle in Norwegian capital. The center to the city center costs nearly 3 $. Automatically control system check out for rules breakers and sends photos of cars to police. All collected resources goes to develop the road network. All parking are paid. There are a lot of zones in the city, the price depends on the number of markets, cultural institutions and others. In "green" zone 1 hour parking costs 6 $, in "red" – 4 $. No one should stay more than 3 hours. Oslo is in 10 times smaller than Moscow, but number of personal cars is nearly 1 million. Bridges, interchanges, tunnels and underground parking are built with the money raised road services, it is – 30 million dollars a year. Half of this amount – the proceeds from fines.

In the capitol of The United Kingdom choose the way to make a paid enter to historical center of the city. Parliament started to work over it in 2003 with West-End and the City, later in 2007 they doubled the price. The center of London with its tiny streets was always with traffic jams and average speed was about 15 km/h at rush hour. 230 cameras was installed at the borders of the center zone. They checked number plates of transport, and the driver should pay 5 £ at one of the ATM's during the day. If the payment wasn't done, drives have to pay a fine 80 £. Invalid and emergency services can enter the center for free. All citizens who live there pay only 10 % from 5 £.

London transport department confirms that such innovations number of private transport in the city center decreased up to 20 %. Average speed of public transport and sales of bicycles and scooters increase at the same percentage. Collected money was invested in developing of transport infrastructure, including installation of new cameras. In February 2007 British government expanded parking zone in twice.

In Netherlands, where population is 15 million people, got only 34 000 square kilometers, that's why they have serious problems with effective use of space. In Amsterdam parking fee is about 3 £ for an hour. By the way it's not so easy to find an empty space. Special services strictly control parking rules, not so long ago the wheel of vehicle was blocked in case of wrong parking, but later that was stopped. Nowadays you have to pay fine 67 £. If it wasn't paid during 24 hours, car would be evacuated. But even if everything seems to be ok, it doesn't mean that driver have done everything right, there are a lot of places to park only for invalids or special vehicles. In that case driver should pay 200 £. Number of private transport increases with the positive economic situation, that means to start using underground area. In 1974, in Netherlands was constructed about 4,5 km of tunnels, in 1999 it was increased up to 10 km, and it's increasing every year. During last 30 years Netherlands have gotten rich experience with engineering tunnels in difficult landscapes, such as underwater tunnels or through mountains [3].

Tokyo solves the problem of traffic jams with developed paid highway network. The main trouble with such system is the center to highway. To eliminate traffic jams was made special contactless way to pay fee.

Japanese government have known about such problems along ago. The way to solve it was founded in engineering highways called «cosocu doro». System of undergrounded and above-grounded highways was made with 2 lines in each way. Tokyo highways justified itself during the first year of exploitation. But 10 years later it was not enough for all transport, so it was decided to innovate enters to highways, using such contactless smart key to use the highway. Nowadays practically every car in Japan got a special key to send information to control system, that sends fee instantly. To pay it citizens can set up a credit card, that can do it automatically. Using such technologies capacity was increased in 4 times. All in all, they don't need to use people, as system is fully automatically and decrease exhaust gases [3].

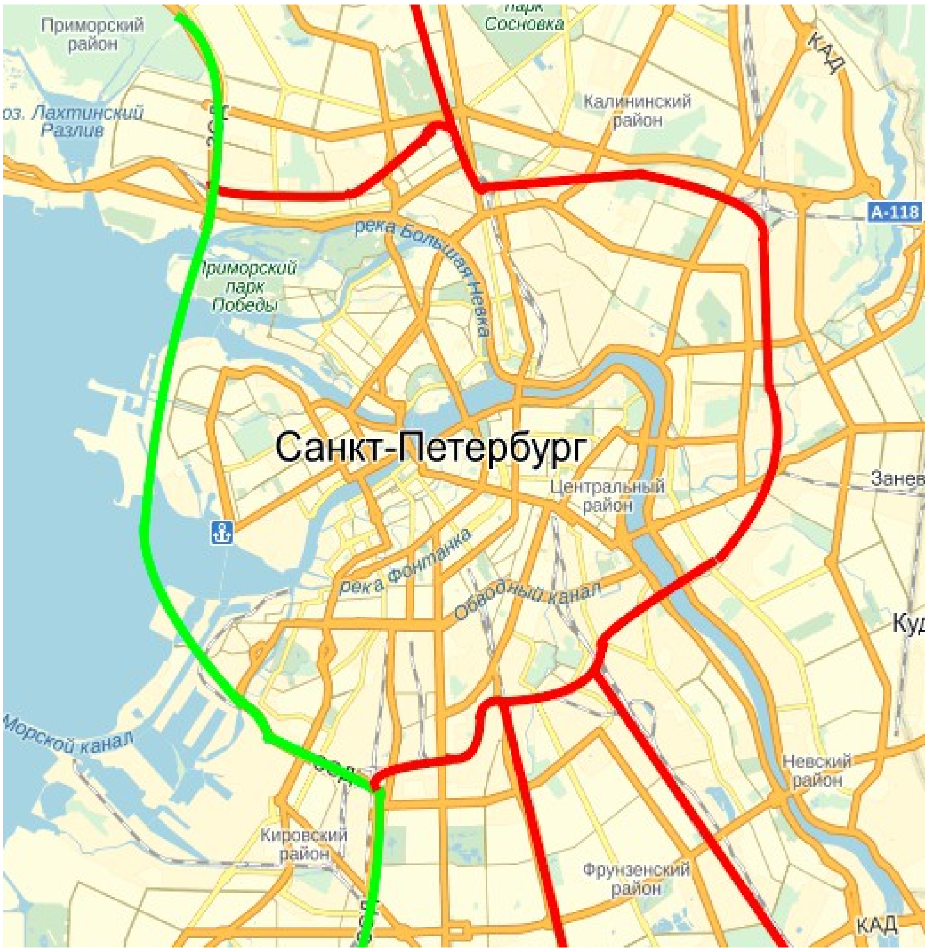

Fig. Green – West High-Speed Diameter, Red – highways above railways

One of the way to solve problems with traffic jams in Saint-Petersburg is using empty spaces above existing railways to increase number of highways. Transport frame of megapolis should be contained with highways and non-stop roads. Nowadays it's made only with the help of Ring Motorway and West High-Speed Diameter, and it's the reason of shortage of highways. Capacity is low because of such problems and total construction of Saint-Petersburg [5]. It's old city with tiny streets and roads, which were not made for such number of transport. Besides that causes no space for parking too. Such troubles with traffic makes citizens to waste a lot of time in traffic jams, especially in the historic center of the city.

Constructing new roads, streets, highways and parking zones should increase this system. Such decision can be solved in 2 ways: developing current system of streets and highways, and constructing future buildings and districts. Formation of new highways above railroads for transport off all kinds has never been used in Russia and doesn't have any analogues. Meanwhile area close to railways is absolutely free from constructions, even low-rise buildings. It allows to use this space to engineer 2 floor highways in some areas to make capacity as much as possible. Such highways system is shown on the picture below.

Saint-Petersburg's Ring Motorway is perfect frame for constructing highways to connect a ring nearby center of the city and existing ring. Central ring and highways to Ring Motorway can add about 70 km using only space above railways.

Certainly, it's a very expensive project, so it should be realized be steps, like it was made during the West High-Speed Diameter construction. Using experience of such engineering each step of building highway can be ready for work in its area, to start paying back before the end of the project realization.

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THE TECHNOLOGY OF PIPELINE COAL TRANSPORTATION AND THE POSSIBILITY OF ITS EXPLOITATION IN RUSSIA

The article deals with the analyses of the coal transportation technology used in the USA. Advantages and disadvantages of this system are studied. Based on this has been formed a decision about the possibility of coal transportation through the pipelines in Russia.

Key words: *pipeline transport, slurry transportation, coal transportation, water supply system*

Introduction

The growth of industry in 21st century requires more and more energy resources. Today the most popular of them is coal. Under the circumstances when the high gastariffs obscure the development of the world economy, coal becomes a more popular energy resource. On the world energy market changing gaze to coal is going on now. Based on International coal institute data the part of coal as the first energy carrier is 25% (it's the second position after oil).According to the forecast of the Energy Information Administration the usage of coal will be increasing on average of 1,5 % per year in the period from 2007 to 2025 [1]. Russia has one third of all coal reserves in the world (173 billion tons) and a fifth of known reserves of coal. Russia is among the coal export leaders on the global market supplying coal into 45 countries. Russian coal is exported to China, Japan, Turkey, South Korea, Germany and other European countries including the UK. In the world the volume of Russian coal exports is about 12 % [2].

As the most part of Russian coal mines are located far away from the sea (the distance from large ports is about 3,5–4,5 thousands km) coal carriers have to use rail road. This is the only ~~one~~ way to transport the coal [3]. It forms the most important characteristic of Russian export: the large component of transportation in its final price. In average price of coal on the Russian market is about 4000 rubles per tone and transportation costs about 1500 rubles per tone based on this transportation fees takes 40 % of coal value. As a result railway tariffs take up the most part of a coal company's profit.

The purpose of the article is to describe an alternative way of coal transportation, to consider the possibility to implement this system in Russia and to show how it can help to reduce transportation fees in coal trade.

As an alternative method to transport coal in article the pipeline coal transport system will be presented. To begin with pipeline coal transportation technology divides into two general types: slurry and log. Slurry pipelines use a mix of water and pulverized coal. The ratio of coal to water is about 1 to 1 by weight. Coal log pipelines use coal that has been compressed into logs with a diameter 5 to 10 % less than the diameter of the pipeline and a length about twice the diameter of the pipeline. The ratio of coal to water is about 3 or 4 to 1 [4].

Coal slurry pipelines

The first operational coal slurry pipeline was built in 1914 in England, and used to transport coal from the Tames River docks into London. However this system gained the greatest distribution in the USA, where the first slurry line was built in 1957 between Ohio and coal mines near Cadiz [5]. A typical coal slurry pipeline consists of three major systems: the slurry preparation plant, the pipeline transmission system, and the slurry dewatering facilities [6].

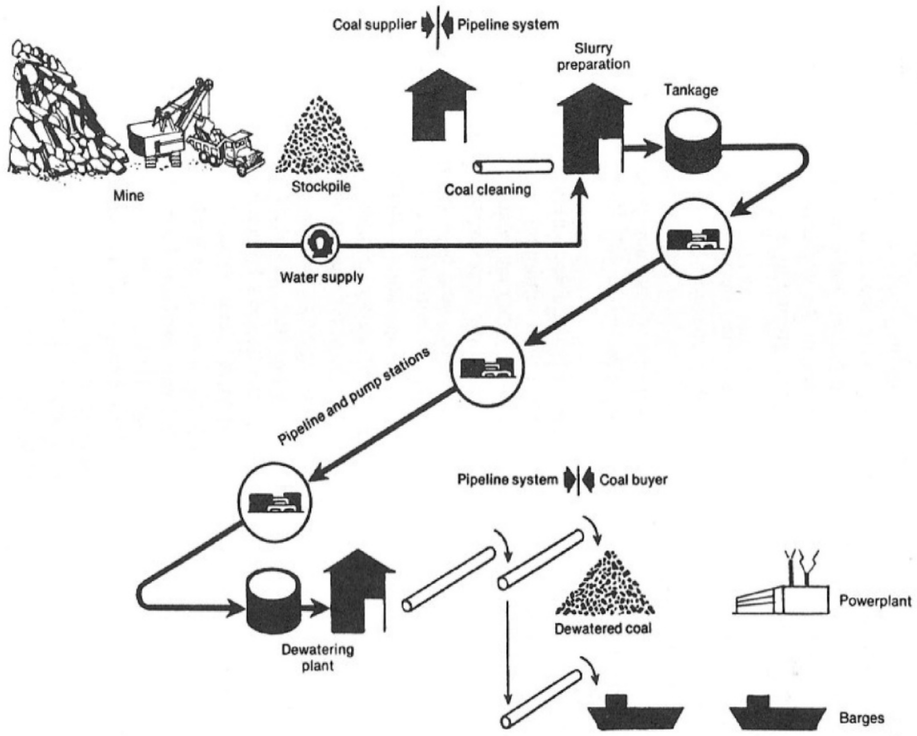

Fig. 1. Schematic flow diagram for a one-way water coal slurry pipeline [7]

These main parts of system are split into the following processes and components.

1) Slurry preparation: coal and water storage, crushing, mixing, slurry storage.

2) Transmission: pipeline, monitoring slurry mixture, pump stations, water storage ponds, dump ponds.

3) Delivery/Dewatering: slurry storage, settling ponds, centrifuge/filtration, drying, storage, water treatment [8].

At the preparation plant coal is pulverized into a fine powder, mixed with equal amounts of water to form the slurry. Slurry stored in a tank in which mechanical mixer is used to settle the mass. After this, slurry is pumped through an underground pipeline system. This process is supported by several pumping stations until dewatering plant, where slurry again accumulates in the tank. At the end slurry should be centrifuged to separate coal from the water. Dry coal powder can be burned at the power plant and the water resting after drying can be used in the systems of cooling [6].

There are two types of pipelines: a non recirculation (one-way) and recirculation (two-way) system. Summing up coal slurry pipelines require preparation of the coal-liquid slurry at the beginning and coal-liquid separation facilities in the end, and should be provided with pumping stations along the route of the pipeline. Requested intervals between the pumps are of 80 to 100 miles. That's why at the both ends of the pipeline slurry storage tanks are usually located. At the upstream end they are used as a defense against downtime of the pipeline system and at the downstream end as a protection from the emergency situations of the coal-using facility. Pipelines are normally should be buried two to four feet below ground to minimize noise and erosion of the land [7].

The most popular and useful economic competitors with coal pipelines are unit trains. A typical coal unit train capacity is about 100 tons each. In average two such trains per week are required to deliver 1 million tons of coal per year [9]. Instead of this for example the 273-mile Black Messa pipeline located in Arizona which has been operating since1970 moved 5 million tons of coal per year. This comparison proves the economic efficiency of coal pipeline transportation system.

This advantage of slurry pipelines consists in the ability to move large amounts of coal over long distances cost-effectively and with a minimum potential for environmental disruption during the route. This is achieved due to the fact that costs for labor are relatively low and amount of energy used for moving the same amount of coal lower than at railroad unit train. However for long distance coal movements compared to railroads slurry pipelines have disadvantages as the huge upstream water requirements and the lower degree of operational flexibility.

These disadvantages can be significantly reduced. For example to decrease the liquid requirements instead of water methanol or crude oil can be used as the transport medium. The second major operational problem with coal slurry pipelines concludes in the limited degree of operational flexibility. It's very important to keep valid velocity of slurry stream between five and six feet per second, or three to four miles per hour. Increasing of the speed can lead to excessive pipe erosion and its reduction can cause coal particle settling and pipe plugging. Once constructed, the coal slurry pipeline is essentially fixed in terms of its carrying capacity [7].

Coal log pipelines

The other way to transport coal through the pipeline is a technology called "coal log pipeline" (CLP) created at the Capsule Pipeline Research Center at the University of Missouri. According to the project this system uses less energy and costs less than current technology coal slurry pipelines. The CLP concept presses coal into the form of circular cylinders coal logs, so that coal can be transported by water flowing through a single underground pipe. The diameter of the coal log is about nine-tenths of the diameter inside the pipe. The coal logs are pressed by a pump by-pass system and travel joined together as trains. After the coal logs are transported to their destination they come out of the pipe onto a moving screen where the logs are separated from the water [10].

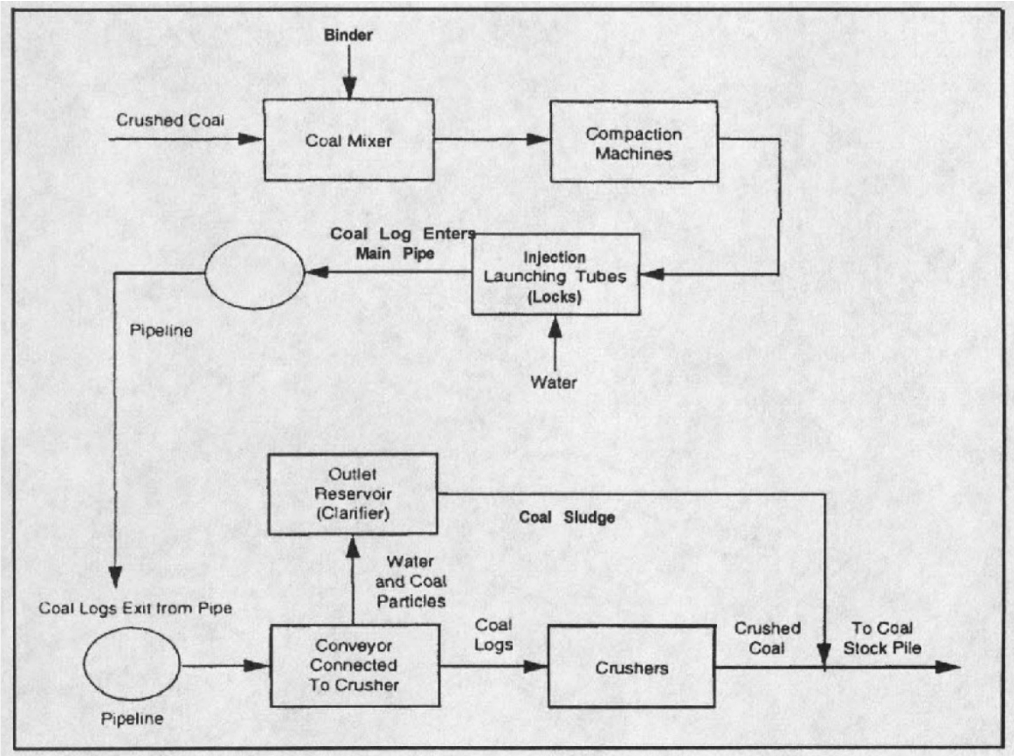

Fig. 2. Coal log pipeline for advanced coal transportation system [10]

Compared with the coal slurry pipeline, the CLP coal throughput is twice as slurry system and its requires one-third to one-fourth less water. The unit cost (dollars per ton) of transporting coal through a CLP is –50 % than the cost of a moving coal through slurry pipeline. The CLP can compete with existing coal transportation systems at distances from 50 to 1,000 miles. An 8-in. CLP has a throughput of about 2.5 million tons per year. This system brings some other benefits**.** First of all it saves up to 70 % of the water used in slurry pipelines while transporting the same amount of material. Then this technology is also suitable for agricultural products, solid waste, or biomass. It affords to much more reduce the usage energy and eliminate abrasion erosion problems [11].

Advantages and disadvantages of coal pipeline transportation

Finely there are some main advantages of the system. First of all under the circumstances where coal is transported through long distances or there are no rail or water ways coal pipelines are more cost effective than any others modes of transport. Besides of being more cost effective, the coal pipeline transportation is also safer for the environment than conventional transportation and has benefits as all pipeline transport. At the same time system has some disadvantages. The most important of them are requiring of huge amount of water and possible environmental hazards. However all described advantages let us to discuss the possibility of its usage in Russia.

It should be noted that pipeline transport is widely used in Russia to transport liquid gaze and oil products. Russia takes second place in world's longest oil and gas pipelines and the first place on volume of work performed by pipeline transport. This suggests that pipeline technology for the transport of goods from our country is not new and its application to transport another type of cargo is possible. An important issue requiring consideration for this system is water. Noted as a disadvantage the need to ensure a pipeline with plenty of water for Russia is an advantage. Russia takes first place on water resources. The territory of our country accounts for about 20 % of all world water. The huge hydropower resources of Russia (320 million kW) are distributed unevenly. More than 80 % of the hydropower potential is in the Asian part of the country, exactly where are located the main deposits of coal [12]. Over 90 % of the deposits located in the Eastern part of the country, mainly in Siberia [13]. Kuznetsk coal basin – the largest coal basin in Russia and one of the largest in the world, which accounts for 56 % of all coal production in Russia, crossed by the river Tom', which is a part of the hydrographic system of the river Ob'. In addition to surface water for pipeline transportation of coal can be used groundwater, pumped through drainage incisions. Specific drainage in large sections is 0.2 to 0.6 m^3/t of coal on small mines it is much higher – from 1.5 to 30 m^3/t. For example, total disposal of drainage water from coal mines of the Kansk-Achinsk basin in 2003–2012 year was estimated at 60–90 thousand m^3/day [14]. While, an amount of about 3000 cubic meters is enough for a two-hour transport coal with the maximum capacity of the pipeline component of 660 tons/hour.

Conclusion

Thus, it can be concluded that the usage of an alternative method of coal transportation described in the article is not only possible, but economically efficient and proved. Despite some shortcomings and financial cost of building a pipeline system, this option of transportation in conditions of huge amount of Russia's water resources and the need to transport coal over long distances will be much more profitable today than transportation of coal by railway.

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THE ESTIMATION OF PROSPECTS OF EXPORT OF FERTILIZERS FROM MANUFACTURERS IN RUSSIAN FEDERATION

The analysis of the ports of Russia on development of growing traffic, including in terms of substitution port facilities in Finland and the Baltic countries.

Key words: *the cargo turnover of the port, transportation, export, fertilizers, container technology*

Mineral Fertilizer Market is one of the few highly competitive global markets, where Russia participates as a competent player, being on the leading places and affecting the whole market conditions. Total world production of mineral fertilizers is characterized by slow but steady annual growth of 3–4 %. In 2014, about 184 million tons of all kinds of fertilizers (by weight of nutritious product) were produced in the world, as well as there have been changes in demand. The Russian Federation owns the world's largest potash salt stocks estimated at 19.7 billion tons, accounting for about a half of the world's reserves. In the production of potash fertilizers Russia takes the second place after Canada, or about 16 % of the world production. The vast majority (98 %) in the production of potash fertilizers in Russia is potash chloride, where the amount of the burnt potash is equal (K_2O), approximately to 60 %. Relatively small volumes of potash fertilizers are potassium sulfate (the amount of K_2O is 50 %). Currently the total capacity for the production of potash fertilizers in Russia is more than 7.5 million tons in conversion to K_2O. Production of mineral fertilizers is the largest sub-sector of the chemical industry. This is one of the most profitable and financially sound industries not only in the chemical industry, but also in industry as a whole. Today Russia owns a significant part in meeting the global demand for mineral fertilizers. The main markets for domestic goods are Brazil (19.3 %), China (12.3 %), the USA (10.5 %), Ukraine (5.6 %) and India (3.3 %). Mineral fertilizers account for about 90 % as part of the chemical goods transported by sea [1].

Russian industry produces almost all kinds of traditional fertilizers being in demand on the both domestic and foreign markets. A complex mineral fertilizers such as ammophos, diammonium phosphate, NPK, etc. occupy a significant share of the production of fertilizers, different from the single mineral fertilizers because they contain two or three nutrients. The advantage of complex fertilizers is that their composition can vary according to the market requirements.

Russian chemical industry has about 40 manufacturers of various fertilizers. About 60 % of the final volume of manufactured fertilizers account for the complex - nitrogen-phosphoric, nitrogen-potassium and potassium-phosphoric, etc fertilizers. The remaining 40 % comes on stream as a single component such as nitrogen, potassium or phosphoric. The main production of mineral fertilizers is implemented by leading holding companies in this industry: "EuroChem", "Uralkhem" and "Acron". During the year 2014 "EuroChem" have created a joint venture "EuroChemMigao" in China and completed the passage of the mine on Usolsky district, Irkutsk region. United Chemical Company "Uralkhem" occupied about 16 % of a given market, and the holding of the company "Acron" amounted to 12 %. 15 plants produce phosphate fertilizers in our country. The leading position belongs to JSC "Ammofos" (Cherepovets, Vologda region), which accounts for about 40% of the total output of phosphate fertilizers in Russia. One of the largest manufacturers of potash fertilizers is OJSC "Uralkali" (Berezniki, Perm Territory), the production of which has reached record results in 2014 to the extent of 12.1 million tons of mineral fertilizers [2].

Almost 50 % of the initial fertilizers (according to its value) produced in Russia, are nitrogen, 30 % are potash and 20 % are phosphoric. The export of a large proportion of single-component fertilizers is sent in bulk and the complex is sent as a finished product in the container. Most of the single component fertilizer market (over 50 %) are potash. Geography of the fertilizer production in the country does not experience any changes over the past decades. The main center for the production of fertilizers is the Ural (2/5 of total Russian production). At the same time the role of the Centre, North-West, Volga region, Volga-Vyatka region in the production area is decreasing. There are the following problems in the industry:

- Old technological production equipment that does not provide the necessary conditions for increasing the production of competitiveness products (in terms of quality and price characteristics); a high degree of wear and tear;
- High energy consumption, significant heat capacity production(the part of energy in production costs of 25 to 50 %);
- Unbalanced tariff system. In the case of unreasonably high energy saves and costs increasing connected with the increase in gas prices, electricity tariffs for railway transportation and freight sea shipping would be a reduction of production profitability of mineral fertilizers, as well as export earnings.

Sea shipping forms on average about 2/3 of total exports. This way of carriage allows the goods transportation to get as much as possible profitable export can by virtue of existing advantages. Firstly, sea shipping is more cost-effective than rail and motor carriage, and flexible in terms of motion path, secondly, they have a high capacity of body. During the period of time from 2008 till 2014 transshipment of bulk mineral fertilizers (physical tons) in seaports increased from 20.54 million tons to 23.94 million tons, including the Russian seaports with the change from 11.73 million tons to 14.69 million tons [3].

In the year 2014, the highest volumes of mineral fertilizers were shipped to the following ports: St. Petersburg, there was 7.58 million tons and Murmansk – 2.86 million tons. Transshipment dynamics of mineral fertilizers in the main Russian seaports demonstrates the general trend of rising rates except for the negative dynamics of the decrease in Novorossiysk.

In the first half of 2015 shipment volumes amounted to 64.23 %, which is more on 5.67 % than the same period of the last year. At the same time due to the absence in Russia of a sufficient number of specialized seaport overload capacities, all Russian exports of mineral fertilizers is mostly carried out in the seaports of neighboring Baltic states and Ukraine [6].

Today, the Baltic Sea is a leader in the total volume of transshipment of all types of cargo. These results are explained by the proximity to European countries and to the industrial regions of Russia. Russian fertilizers are mostly agreed to sell on the terms of FOB. The buyer pays the sea freight and bears the costs for unloading in a foreign port destination. These costs per ton of cargo on ships of small-scale group are significantly outweigh the costs by using large-capacity fleet. At present, the main competitors on the world market for Russia are Canada, the US and China, these countries are switching to ocean-going fleet for export supply to the countries of these regions of the world. Russian seaports on the Baltic Sea, on the whole, have greater opportunity than the main seaports of the country in the south. To a large extent, this is the reason for more intensive development of the trans-shipment of fertilizers in the Baltic seaports.

Seaports of the Baltic Sea have a broad infrastructure established to improve the efficiency of transshipment works on mineral fertilizers. Thus, the leading seaport in the transshipment of mineral fertilizers is St. Petersburg, in which the volume of mineral fertilizers amounted to 7582.6 thousand tons exported in 2014, higher than in 2013 with 1559.9 thousand tons. Baltic Bulk Terminal has operated in St. Petersburg seaport since 2003 built for the transshipment of potash and nitrogen-phosphoric fertilizers. Maximum transshipment capacity is 6.2 million tons per year, but in fact for 2014, according to the Port Maritime Administration, it was shipped 7.6 million tons of fertilizers. And fertilizers transshipment growth for the year amounted to 26 % plus 1.5 million tons[5].

"Fosagro" Group is one of the leaders of the Russian mineral fertilizer market, together with the logistics operator "Ultramar" in June 16, 2015,it put into commercial production the Ust-Luga seaport to the terminal for transshipment of mineral fertilizers. "Smart Bulk Terminal" (SBT) has already allowed producers of fertilizers to tranship from 1.5 million up to 2 million tons per year and to replace the seaport equipment located in Finland and in the Baltic countries, by the Russian ports [8].

Also, it contributes lot to the tariff conditions and shipment of fertilizers (see Fig.). In such a way, transportation of nitrogen fertilizer from the Smolensk region with the help of Ust-Luga is 31 % cheaper than through the seaports of Kaliningrad and the Baltic republics, despite the fact that the distance from the shipping point to the Ust-Lugais 57 km more. The tariff for the fertilizer shipment, in Lithuania is 3.3 cents per ton / kilometer, on the territory of Belarus is1.4 cents, and on the territory of Russia is 0.9 eurocents.

The Ust-Luga project is financed by proprietary funds of the investors in proportion to their shares in the "Smart Bulk Terminal" (70 % owned by "Fosagro" 30 % – "Ultramar"). The designed capacity of the terminal provides transshipment up to 3 million tons of fertilizers per year with the possibility of further increasing capacity. Currently, SBT is able to tranship up to 180 mineral wagon cars per day (about 12 thousand tons of mineral fertilizers), and the transshipment pier operating equipment is capable of providing vessels with a capacity of up to 15 thousand tons per day.

Fertilizers transshipment is carried out from the cars in the vessels, with the accumulation of the shipload in specialized containers. When this container is used as a transportable storage element, it allows to accumulate different shipload fertilizers. The simultaneous storage capacity is about 80 thousand tons. Containers were created by special order, the company China International Marine Containers was the supplier [7].

The China International Marine Containers produced 2.5 thousand containers for the terminal corresponding to the volume of 80 thousand tons of cargo. It is expected that with increasing transshipment capacity of the terminal number of containers will be increased to 5 thousand pieces. For the China International Marine Containers, that is one of the largest suppliers in the shipping containers market, participation in the SBT project was the first experience on the Russian market [4].

JSC "Fosagro" intends to use SBT for transshipment of about a half of its exports (over 3.0 million tons per year), shipping fertilizer to 100 countries. Earlier it was reported that the use of the new terminal will allow the company to save about $ 8 per ton of production compared to the transshipment through the more distant and expensive seaport capacity.

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THE PROJECT OF THE CONSTRUCTION OF THE CANAL BETWEEN THE CASPIAN SEA AND PERSIAN GULF

This article raise the issue of the construction of the project of canal between the Caspian sea and Persian Gulf on the subject of its prospects, obstacles of the construction, its positive and negative effects. Below there are its features and also expert opinion. This article has a map of the canal location.

***Key words**: the canal, the project, the construction, the Caspian Sea, Persian Gulf, Iran, Russia*

Introduction

Maritime transport is crucial for the implementation of foreign economic relations. It provides more than 4/5 of all international shipments. Cost price of transportation of goods by sea is the lowest in transport.

One of the objectives of logistics is to reduce transportation costs. Globally, this is realized by laying routes along the "direct" line. In practice, the reduction of transport costs is achieved through the canals laying. At the moment, a promising project is the construction of the canal around the Bosporus (the shipping canal between the Caspian sea and Persian Gulf). The relevance of this canal was a long time. Its construction has been discussed by Stalin and Brezhnev.

Main arguments

Since the 1890s, Russia's relations with Iran were largely determined by the project of the navigation canal The Caspian Sea – Persian Gulf. Designed by Russian engineers in 1889–1892, the project provides the shortest access from Russia to the Indian Ocean basin, the Turkish straits of the Bosporus and the Dardanelles will be useless for this purpose [1].

Preservation of Russia's dependence on the route through the Bosporus and the Dardanelles was and remains one of the strategic objectives in the West's region [1]. This project, subject to its implementation, is of strategic importance for Russia. But the West with Turkey directly or indirectly hinder the creation of this highway.

Joint Russian-Iranian commission of the construction of the canal, created in the end of XIX century, began its work in 1904. In 1908 negotiations were postponed by the growing pressure on Tehran from Istanbul and London on the new canal status and the timing of its construction. Throughout the 20th century Russia and Iran have repeatedly returned to this project but various reasons discontinued its development [1].

Fig. Iran's location relative to sea lanes

The canal the Caspian sea – Persian Gulf directly brings out to the Indian Ocean, not only Russia, but also most of other countries of the former Soviet Union, as well as Europe. It completely passes through the territory of Iran, and it is able to provide the shortest access to the Indian Ocean basin from the North Atlantic, the Baltic, the Black Sea and the Azov Sea, the Danube and the Volga-Caspian basin. For potential users this road is more than half shorter than the traditional water route through Turkey. Because the finalization of the project involves not only Iran, but also foreign experts. Entry of the Canal is planned in the 2020s [1].

The total length of the waterway is about 700 kilometers, including the fairways of the rivers of northwest (the Caspian Sea), and south-western Iran, including the international channel of the Shatt al-Arab, bordered with Iraq, about 450 kilometers [1]. The canal will be used mainly for vessels of mixed type "river – sea" [3].

The required investment for the construction of the entire highway was evaluated by the Iranian side in 2012-2013, at least 10 billion, including the connecting transiran area (north-west – south-west) – to 5.5–6 billion dollars. The total payback of the project will come, according to local estimates, on the fifth year from the date of commissioning. According to the same calculations, the Canal will provide Russia and Iran transit revenues - respectively 1.2–1.4 and 1.4–1.7 billion dollars, since the third and fourth year of the operation [1, 2].

The big advantage is a real opportunity to drastically weaken the dependence of the Russian transit from Turkey and at the same time to reduce by one third the distance traffic with the countries of the Middle East and by a quarter – with the countries of South and South-East Asia [7].For Iran this is a great opportunity to move from the export of raw materials to transportation and processing activities, which will allow it to gain a new degree of economic independence [4].

However, in this project there are a lot of negative effects, which are the cause of the repeated interruptions of project development. One of the main reasons is the discontent of other countries (particularly the USA, Turkey) and all possible influence on Iran to suspend the project. Since the late 30's years Soviet-Iranian relations had been beginning to deteriorate, which was caused by the active influence of Britain, Germany and Turkey on the foreign policy of Tehran [6]. In 1997, anti-Iranian US sanctions were extended to the project construction of the Canal the Caspian – Persian Gulf. More specifically, companies and countries providing assistance to Iran in realizing this plan were exposed to financial and other economic penalties [5]. Also in March 2016 the US Court ruled that the Iranian authorities must pay more than 10.5 billion dollars in compensation for the September 11, 2001 (it is equal to the sum of the canal construction) [9].

Under the plan diversion of 500 million cubic meters of water from the Caspian Sea to the central regions affected by drought, and its use in the agricultural sector and the industrial sector is planned. According to the experts the use of such water for agricultural purposes is not possible because it is too salty for agriculture. Desalination is unprofitable too [6].

In addition to the barrier of the Alborz mountain range on the north, these regions are densely populated, for the implementation of construction work it is necessary to evacuate the population and ones must be paid the compensation. The distance from north to south of Iran is two thousand kilometers, a length of the Canal can not be constructed from concrete [5].

In addition, Iran is among the ten most earthquake-prone regions of the globe, there is an earthquake of magnitude greater than 7.0 on the Richter scale in almost every ten years [5].

The difference in altitudes of regions in the north and the south of Iran, including the low level of the central areas and the area to the south of the Caspian Sea (northern Alborz Mountains), will lead to flooding, which also leads to the intensity of earthquakes. As a result of the earthquake some of the dams will be damaged, it is not difficult to imagine the scale of possible flooding. In areas where floods happen, 300 small earthquakes are usually recorded in a year. If there is a flood, the tremors will be intense. It should be noted that spring floods are quite frequent in the mountains of Elburs or Alborz [5].

Between the Caspian Sea and Persian Gulf there is a large height difference, as Iran - a mountainous country, and the Caspian Sea is located 29 meters below sea level [8]. Therefore, the canal should be constructed with large number of gateways.

Experts believe that the shipping canal should be wider than 100 meters and have a depth of at least five meters. Such a canal needs a huge amount of water, at least 10 % of the water of the river Volga, which provides 85 % of the water of the Caspian Sea.

Without the permission of the Caspian states to transport this amount of water from the Caspian Sea is not possible [5].

On the other hand, the intention of the Iranian authorities to build a canal 700 kilometers long to throw in the interior of the country of 500 million cubic meters of water (about 10 % of the annual flow of the Volga) causes serious criticism from environmentalists [6].

It should be noted that as a result of shoaling of shelf additional funds for dredging in the waters of a number of ports, including the ports of Olya, Makhachkala, Aktau, Atyrau, Turkmenbashi, Alat will have to be raised. Shall owing of the shelf will lead to greater evaporation from the water surface [8].

Conclusion

Based on the above mentioned, we can conclude that this project is utopia and will not be realized in the nearest future. The big plus of this project for logistics is a significant reduction of the way, but in contrast there are a huge number of various negative factors (economic, political, environmental, etc.), which leave in doubt on project development.

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INFLUENCE OF THE NEW SUEZ CANAL ON WORLD NAVIGATION

The construction of the Suez Canal in the 19th century had a noticeable impact on worldwide shipping. The modernization of the water artery continues to the present time; and one of these transformations is the opening of a new branch of the Suez Canal. It is planned to further development of infrastructure around the channel including tunnels for vehicles, shipyards and car assembly plants. This set of projects will be the center for a peaceful coexistence in the region, the center of trade and international cooperation. However, whether all so perfect, and whether the channel needed a speedy modernization, is considered in this article.

Key words: *modernization, channel, expansion, project, cooperation, expectation*

Introduction

The construction of the Suez Canal in the 60 years of the 19th century played an invaluable impact on worldwide shipping. The modernization of the water artery continues to the present time; and one of these transformations is the opening of a new branch of the Suez Canal. The advantage of this design is that the channel will allow the passage of vessels in both directions on the large number of sites; it gives the possible to reduce waiting time in the queue, to reduce time of a access of vessels on the channel, reduce the movement of the vessels through the channel and increase the capacity of the courts. Moreover, it is planned to further development of infrastructure around the channel including tunnels for vehicles, shipyards and car assembly plants. This set of projects will be the center for a peaceful coexistence in the region, the center of trade and international cooperation. However, whether all so perfect, and whether the channel needed a speedy modernization, I will try to deal directly in the article [1].

August 6, 2015 the New Suez Canal was inaugurated. It was a historic symbol of the post-revolutionary revival of the country for most Egyptians. Prospective investment in hydraulic installation, according to analysts, will increase the revenues of Egypt by 2023 in 2,5 times. However in general, experts have different views, concerning economic effect of the Egyptian "building of a century" which risks to remain purely symbolical.

The project description

Modernization of the Suez Canal in essence consisted in broadening and deepening the current path and the creation of a parallel. It will allow to conduct the vessels to both parties without sediment on spare parking in salty lakes. Thus, pilotage becomes simpler, time of passing of the channel will be reduced from 18 to 11 hours, and the waiting time in the queue for the passage of ships over the channel is reduced to

3 hours. At the same time the number of passing vessels is capable to increase with 49 to 97 in days. Egypt believes that expansion will allow to double proceeds from operation of the channel from 5,4 to 12–15 billion dollars a year. Even now about 7 % of world sea goods turnover pass through "neck" of the Suez Canal whereby the channel was the second source of the earnings after tourism for Cairo [2].

Also in the coming years, the Egyptian authorities are planning to turn the territory along the canal in the international economic zone with the logistics and industrial centers with the participation of foreign investors. According to the experts, the company of the Arab countries of the Persian Gulf, Indian, Chinese, Israeli and Russian are interested in attending this project [3].

It should be noted that The New Suez Canal was built in record time and internal resources of the country. The financing of the canal has been received for eight working days. The Egyptian banks have issued investment certificates for five years with a coupon rate in 12 %. The Egyptians did not believe fully that this huge project will implement as soon as possible. Experts were confident that the deadline of the project – three years, but President al-Sisi gave on realization only year, during which the most important shipping artery was upgraded [4].

Thus, the government of Egypt has shown that it can keep the promises just in time. Thus, the Egyptian government has shown that it can deliver on its promises on time. In addition, every major construction is beneficial to the authority of the heads of state and government. Implementation of the project has cost at 8.5 billion dollars [5].

As for payback of the channel, it is possible to tell that it depends on growth of world trade. According to the estimates of experts, world trade has to grow at high rates reaching a minimum of 9% per year, in order to justify the realism of the growth of maritime transport through the channel, at the moment it grows to a maximum of 6%. On the other hand, the Suez Canal takes about 10 % of world sea trade that is rather high rate. In these circumstances, the Suez Canal can only rely on an increase in tonnage of vessels passing through it. According to Dcode Economic and Financial Consultancy which investigated economy of the channel, from 2009 to 2014 the number of the ships has decreased by 0,4% .However for the same period the average tonnage has grown by 31 % [6].

And then the question arises, was the New Suez Canal really necessary?

Of course, modernization - it is always good, but when the costs will justify itself spent on this upgrade. On the one hand the channel always was and will be attractive to consignors, even without any improvements and urgency as such was not in this upgrade. Estimates of future profits, based on the forecast of 97 ships a day, look too optimistically, especially considering that the demand for oil and oil products has fallen in Europe and the USA (and it was the fifth part of all cargoes going via the channel in 2014).

But, on the other side the project of the Suez Canal is very interesting, both to Egypt and for world shipping in general. Expansion of the Suez Canal could guarantee raising of the patriotic spirit split by revolutionary shocks of society and effective consolidation of own positions of the president of the country, especially in the context of active foreign policy.

Also it is still main route of cargo delivery from Southeast Asia in the direction of the European Union. The money received for transit will be used by Cairo for strengthening of geopolitical positions. Including, on purchase of arms which can become also the Russian arms.

The Suez Canal becomes even more important link in the Chinese logistics. Since the sharp growth of a traffic has come from China in recent years. The flow of the Chinese goods, goes through Southeast Asia, along South Korea and Japan, and further through the Strait of Malacca. And then China has two options – to send goods the South, bending around South Africa, or through the Suez Canal.

However prospects of the Suez Canal are a little foggy. Not the fact that all traffic from Asia will go to Europe via the channel because in the future alternative routes can appear. For example, the expanded Trans-Siberian Railway – delivery of the Chinese goods to Europe the railroad quicker, than the sea or a road "Silk way" which construction will finance BRICS or the reconstructed Northern Sea Route which is much shorter, than the southern route through the channel.

Also in this project can be traced important geopolitical point. Suez Canal – one of the most important arteries for transportation of oil from the Persian Gulf. The situation has stabilized around the Iranian nuclear program and Tehran expects a gradual lifting of international sanctions. This put an end to its international isolation and makes Iran, which has the fourth largest oil reserves, a full participant in the global economy.

Thus, Iran can increase oil production in the medium term to 2.5 million barrels per day after the lifting of sanctions. This oil can go through the new Suez Canal. As a result, Egypt will be able to make good on the Iranian transit [7].

Conclusions

As one can see, judge the future prospects of the new channel is still quite early, this modernization has its advantages and disadvantages, and whether expectations of the Egyptian government will be met depends first of all on unpredictable world economic trends.

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THE IMPACT OF THE NEW PANAMA CANAL ON THE WORLD SHIPPING

This article considers the problem of the impact of the new Panama Canal to world shipping. It provides basic information about what has been done at this stage of the modernization of engineering miracle, and also identifies the major canal expansion and the timing of the work. The article analyzes the impact of the opening of the Panama Canal to the ports of America, the future of rail transport, as well as presented the estimated revenue from the updated canal operation and its cargo turnover. At the end concluded that the impact of the opening of the Panama Canal on the shipping market.

Key words: *The Panama Canal, waterway, shipping, «Panamax»*

Introduction

Marine channels are very important for the development of world shipping. To international maritime channels are Suez, Panama and Kiel. The construction of these channels has significantly reduced the sea and ocean routes between many countries, which increased the turnover of vessels, reduced transport costs and time to transition from one port to another. Due to their geopolitical situation, The Panama Canal has had inestimable influence on the development of navigation and the overall economy in the Western Hemisphere and throughout the world. The largest ships that can pass the canal today are called Panamax. However, the global shipping grows, ships sizes were on the rise, and now this engineering wonderwork cannot cope with assigned duties. As the opening of the renovated canal is planned for this year, and so the possible changes in the shipping industry and market redistribution will occur in the near future, this topic is relevant.

Analyses of the current situation

The Panama Canal is a gateway canal in Panama that connects the Atlantic Ocean to the Pacific Ocean crossing the isthmus of Panama. a Panamax ship will usually have dimension of close to 965 ft long (294m), 106 ft wide (32.3 m) and a draft of 39.5 ft (12.04 m). With these characteristics ships pass through canal back to back and have very limited ability for maneuver [2].

The Panama Canal is a man-made canal in Panama, which was opened on 12th June, 1920. Due to Panama Canal sea route from New York to San Francisco was reduced from 22.5 to 9.5 thousand kilometers. The Panama Canal was built and put into operation more than 100 years ago, but because it physically and morally outdated and canal does not meet the requirements of the fast growing world trade (especially after the beginning of the expansion of China's foreign trade) [1].The Panama Canal has long been unable to cope with the modern freight traffic, with severe restrictions on the parameters of passing ships. Its gateway infrastructure is outdated. Container ships with capacity more than 5,000 TEU simply will not pass through a gateway. Nowadays modern largest container vessel MSC Oscar has a capacity of up to 20,000 TEU.

New Canal reasoning

In addition to moral ageing, one of the other reasons for the reconstruction is competition. Today the project is developed canal crossing Nicaragua. Other Central American countries, including Mexico, have proposed to build canals on its territory [3].

The Panama Canal expansion referendum was held on 23th October, 2006, when 79 % of the citizens of Panama approved the Panama Canal expansion project, because thousands of new jobs will be created during its implementation. This is the largest project on the reconstruction of this water transport route since it was opened.

In 2008, the Panamanian government has announced a tender for the modernization of the canal. It was won by a consortium of firms headed by Spanish construction company Sacyr Vallehermoso. The consortium also includes the Italian company Impregilo, Belgian Juan de Nul and the Panamanian Constructora Urbana. In 2009, Panama started extensive working on the construction of two lock complexes, one on the Atlantic side and another on the Pacific side, each with system, which include water-saving. The widening and deepening of existing navigational channels are completed. the elevation of Gatún Lake's maximum operating level is finished [4].

It had supposed complete the modernization of the channel by 2014 year to mark the birth centenary of Panama Canal. However, due to cracks in the concrete of the new Cocoli Locks complex, located on the Pacific side of the Panama Canal which was found on august of 2015 opening date was moved. After two years of delays, and speculation on the new opening timeframe for the Panama Canal expansion project, locks opening now expected in second quarter, 2016 [6].

Updated waterway will become navigable for class Post-Panamax vessels with a DWT of up to 120 thousand tons, 50 % more than a Panamax-type vessels, including container ships with a capacity of up to 13.000 TEU, which are approximately three times the size of ships that can pass through channel today. After the reconstruction The Panama Canal will able to pass ships with 366 meters long and 49 meters wide, which is about one and a half times larger than now. But even after the modernization of the Canal locks will not be able to handle ships of this class, like Oscar [2].

Every year Some 13 to 14 thousand vessels, carrying about 300 million tons (5 % of the global ocean freight), use the Canal. Upon completion, the capacity of this waterway from the Pacific to the Atlantic Ocean will increase twice – from 300 to 600 million tons per year and it will have a significant impact on international maritime transport [2].

It is assumed that the expanses of the channel pay off for ten years. After the channel is upgraded, the total volume of goods transported through it, will be increased by three per cent a year [5].

In addition, the new system of water reservoirs will be more effective, consumption of water should be reduced by 7 % in comparison with existing gateways. Moreover, 60 % of the water will be reused in each locking cycle [6].

The project will result in a growth in turnover of all ports with the redistribution of the market and the introduction of significant changes in the formula for calculating the cost of delivery, which is used by cargo owners. According to preliminary information, up to 10 percent of container traffic to the U.S. from East Asia could shift from West Coast ports to East Coast ports by 2020. For example, China is now the biggest US partner in Asia, prefer to deliver the goods only to the ports of the West Coast, and then ship it by ground transportation to the cities of the country. The alternative is either to use small boats, or carry goods going around the southern tip of South America. China chooses inland transportation, despite its relatively high cost compared to the sea. If the vessels with large capacity can pass the Panama Canal, the entire eastern part of the United States will receive goods through East Coast ports. This will, firstly, to the decline in the pace of development in the western port, and secondly, to a jump of the pace of development in the eastern ports, in the third, to the end of the Panama Canal modernization, the popularity of rail freight strongly falls (for example, China prefers not currently use the channel, and to ship the goods to the ports on the west coast of America, for example, Los Angeles, and then transport them by rail or road to New York and other cities) [7].

After opening of the channel priorities will be replaced in the US list of ports: the West Coast ports, including the largest complex of Los Angeles – Long Beach will show growth of no more than 5–10 % per year, the Eastern ports, primarily complex New York – New Jersey – at times more [8].

But it should also be noted that some of the ports of the East Coast are not ready for the redistribution of marine traffic: for example, from the southeastern port of Norfolk only able to accommodate vessels with a capacity of more than 7.000 TEU. The remaining terminals are urgently looking for investors to expand. Charleston, for example, has received $ 700 million. For the modernization of infrastructure, and expects another $ 1.3 billion in the coming two years. There are going to spend $ 550 million on the tunnel that will connect directly the port and the major highways of the state. There is plan to rebuild the bridge Bayonne, making it up to 20 m, so that it could pass a large container ship.

Conclusions

It is expected that due to the reconstruction that by 2017 year the budget of Panama will receive US $ 2.5 billion/year revenue by channel, and by 2025 revenues will grow to $ 4.3 billion/year [5]. Summing up, we can say that the completion of the modernization of the Panama Canal will significantly boost overall economic activity in the country, a sharp increase in the flow of goods stimulates production and employment. The Canal will be able to use large container class Post-Panamax, and currently 30 % of the global container fleet is just such a judgment. From the expansion of the Panama Canal will lose not only the western ports, and logistics companies. In particular, this is about the Burlington Northern Santa Fe Corporation (BNSF), which loses some of their orders when the Panama Canal will be expanded. Updated Panama Canal will help to develop ports on the east coast of the US [8].

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NETWORK ARCHITECTURE ASSESSMENT IN CARGO DISTRIBUTION SYSTEM OF MARINE CONTAINER TERMINALS DESIGN

The article contents the results of a network architecture assessment in cargo distribution system of marine container terminals design. The concept of container distribution system was analyzed in details, the definition of the concepts of transport network and transport hub was given. At the moment loads are consistently interacting chain terminals (container platforms) performing distribution function. The article describes the topology options of distribution networks, the general architecture of echeloned container transport-technological system is considered, the composition of the elements of the system is analyzed.

Key words: *multimodal shipping, regionalization, transport systems, container terminals, network architecture*

Introduction

Container transport system, or container distribution system combines transport infrastructure, enterprise transportation management and vehicle-oriented unified transportation containers – metal containers set size [3].

Modern container distribution system is characterized by a high dependence on the channels of communication and information technologies and developed in the following areas:

- Increase the capacity of transport networks;
- Reducing the length of stay in the cargo transport units;
- Increase in transport vehicles size;
- Increase in the overall speed of container shipping.

Transport distribution infrastructure container system includes a transport network (hereinafter – the network), i.e. channels, as well as transportation hubs, the place where the transport is carried out change.

Under the terms of mathematical graph theory, i. e., list of discrete mathematics, to study the properties of graphs, in a general sense hubs are represented as a set of vertices (nodes) connected by edges – transport networks:

$$G = (V, E),$$

where V there is a subset of any countable set, and $E - V \times V$ subset.

Transport networks distribution container system (ribs) – a set of main transport channels of different modes of transport with the necessary devices to ensure the movement of containers between the nodes (vertices).

Transport container distribution system (top) – a complex transport devices at the junction of transport, together performing the operation of container handling.

The transport unit as a system – a set of transport processes and tools to implement them in the field splicing two or more of the main modes of transport. The transport system components have the function of regulating valves. Failure of one of the valve can lead to problems for the entire system.

The network architecture of a container distribution system determines the composition of the main elements of the network, the network topology and describes its overall logical organization, technical support, defines the principles of interconnection elements (fig. 1).

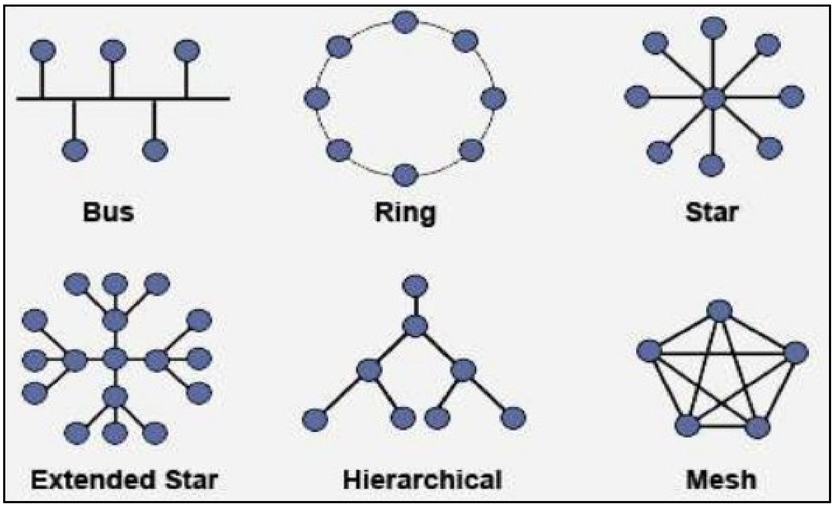

Fig.1. Topology of transport networks

Network topology – a configuration graph, whose vertices correspond to the transport network nodes and edges – transport links between the nodes. The simplest network topology is a mesh topology in which all transport nodes interconnected transport channels. More perfect is a hierarchical topology (fig. 2.).

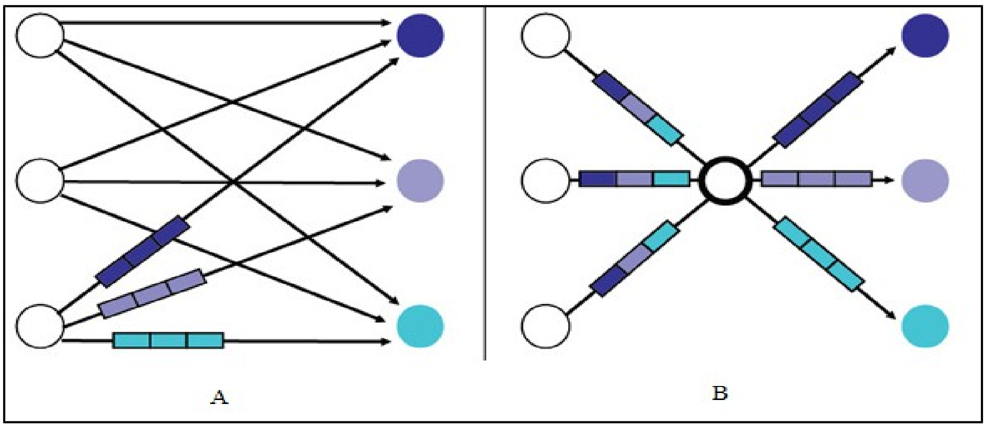

Fig.2. Mesh (A) and hierarchical (B) topology of transport network

The hierarchical topology of container distribution system involves the passage of cargo flows through the distribution centers that serve customers in the region due to the developed distribution network. Considered topology involves focusing resources on the main transport nodes distribution and cargo traffic passing through them to address end customers [2, 4].

The transition from a mesh topology of distribution of marine container terminals to the network in a hierarchical topology hinterland, along with the integration of maritime, port and land transport infrastructure called the regionalization of ports. Distinctive features of the process of regionalization of ports – a close link of the transport market participants – (sea and land carriers, and ports), joint development of infrastructure and logistics platforms, the formation of regional logistics centers. The main causes of the phenomenon of regionalization – the load increase of the transport system, the lack of land for development of seaports, environmental restrictions, and changes in the formation of global trade flows, process that is not under the power of the individual participants of the transport market.

For regionalization seaports enough only occurrence of certain distribution logistics centers and the rear terminals. Regionalization involves the creation of an organized network of transport corridors and distribution centers in places of concentration of cargo flows [1, 3].

The transition to a hierarchical network topology of distribution has the following key benefits (fig. 3):

- Opportunity to organize a network with a large number of clients;
- Providing centralized cargo management, security and access to the networks;
- High speed of passage of the cargo from the port to the customer and vice versa;
- Possibility of reducing the client's costs by providing a full range of services and rates to the "to-door".

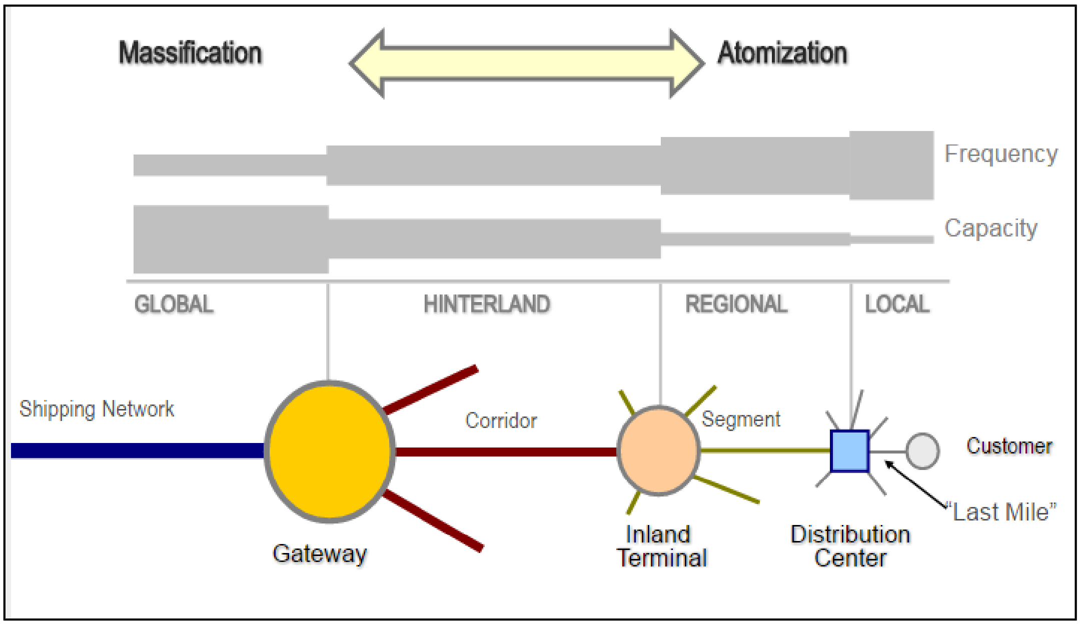

Fig.3. Classification of hubs and networks of container distribution system

Hubs of container system container marine terminals timing system are the following facilities:

– ***Rear container terminal*** – multimodal processing facility, which is a terminal or group of terminals, engineering network, transport and administrative infrastructure to service capacities of marine container terminals and cargo areas of ports, including through the implementation of operations for commercial storage, consolidation and distribution of cargo parties, logistics improvement.

– ***Distribution Logistics Center (RLL)*** – multimodal network processing facility, which is a terminal or group of terminals, transport, administrative and engineering infrastructure to service the regional transit and freight traffic, which allows customers to receive a regional logistics services of added value.

– ***Satellite*** – terminal or group of terminals associated with the distribution logistics centers united technology of cargo handling and performing auxiliary operations for RLL.

Formation of high ground system distribution marine container terminals also includes the use of these system solutions – multi-level functional structure of objects, building a hierarchical topology, the availability of commercial networks with high bandwidth.

The development of commercial networks with high bandwidth necessary to carry out on the basis of the existing rail infrastructure, which involves the following steps:

- Development of infrastructure for the landfill of trains on schedule – web patrols, alarm, centralization and lock;
- Provision and dispatch of trains on the "Threads" schedule regardless of the applications received for transportation;
- Care of the sorting work and its replacement cargo handling network RLL and rear terminals;
- Terminal train handling without tearing the compositions within the established limits;
- Providing free access to customers and the creation of information portals and public access systems;
- Implementation of a uniform tariff and technology policies.

Port Regionalization imposes stringent requirements on the transport system in terms of the creation of an integrated information system to improve the supervisory control, optimization of transport and storage processes [6].

As part of the transition to a hierarchical network topology distribution needs a balanced approach to the allocation distribution hubs. The main factors that determine the choice of location nodes:

- Maximum use of existing transport infrastructure and land already owned by the transport company;
- Availability of existing railway stations contiguity sufficient gridiron and reserve bandwidth for a gradual entry into operation of terminals;
- The maximum proximity to the major transport hubs, centers of origin and completion of cargo flows, current highways;
- Provide potential areas of water supply, sewerage and electricity.

Conclusions

Creating a high-performance ground systems distribution marine container terminals can improve the overall efficiency of the national transport system is the engine of development of the market of logistics services, is expanding range for transport activities and to improve the efficiency of carriers by reducing the cost of transportation and infrastructure optimization download.

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TRENDS IN DEVELOPMENT OF LIQUEFIED AND COMPRESSED NATURAL GAS TRANSPORT

The article describes the transport of LNG and CNG by sea and conditions that must be observed in transportation. Being the cheapest form of fuel, it has great prospects for development.

Key words: *Liquefied Natural Gas (LNG), Compressed Natural Gas (CNG),transportation, prospects of development*

Introduction

Transportation of liquefied gases by sea began in 1929-1931, when the Shell transport and trading company temporarily re-equipped the "Megara" tanker. Soon several dry cargo vessels were turned into liquid gas carriers for Norwegian ship-owners. "Rasmus Tholstrup" was the first dedicated liquefied-gas vessel, constructed in Sweden in 1953 for Danish ship-owners. In the USSR transportation of liquefied gas began in 1960, when the "Frunze" tanker was re-built for simultaneous transportation of oil and ammonia. First dedicated liquid gas ships were "Kegums" and "Kraslava" built in Japan and launched in 1965 [3].

Gas classification and transportation

LNG is cooled to temperatures of –160 °C when it turns to a liquid, becomes 650 times heavier, and is easier to store and transport[5] Additionally, it is much cheaper to transport it in liquefied rather than in gas form. LNG is generally recognized as a cost-effective clean alternative fuel, which plays a major role in supplying the world's energy. However, the gas belongs to the class 2 of Dangerous Cargo by IMO; therefore, there are a number of rules and standards, which must be followed to maintain safety during transportation [1]. Those are:

- Storage, transportation and use of the substance must be done at a pressure excluding the liquid-gas conversion.
- It must be ensured that containers used for storage and transportation of liquefied gas will not leak.
- When organizing gas supply system, it must be taken into account that gaseous substance is twice as dense as air.
- When filling the tank with liquefied gas, it is necessary to keep at least 15 % of the total volume empty because once temperature outside rises, the pressure of any liquid substance increases.

CNG is stored at high pressure (over 200 bar) and will be a principle fuel of the future, rather than an alternative one. There are motor vehicles which run on CNG only, like buses or vans. Recent years witnessed a rapid development of CNG engines.

CNG advantages:

- Transportation of natural gas through pipelines does not involve additional costs which in other cases would occur because of the danger of damaging the environment;
- Minimum maintenance expenditure;
- Public transport in countries, which are sensitive to the environmental pollution, uses natural gas;
- Auto ignition temperature of CNG is 650 °C, which is why CNG is very safe;
- Natural gas is the most efficient type of fuel today.

In 2010–2011the first CNG vessels were built. In Russia, R&D in this area is limited, this limits the potential benefits which may be gained from its future use [2]. A key feature of the new technology lies with the creation of competitive CNG vessels, the main element of which is a cargo system for the loading/unloading of natural gas, its preparation, compression and storing in cylinders under pressure. Natural gas transportation on CNG vessels will be cheaper than transportation by marine pipelines or in LNG ships. Global demand for natural gas is growing steadily accompanied by depletion of natural gas resources in the traditional producing regions. It stimulates the development of new investments and the search of cost-effective technologies of natural gas transportation on the main markets. Cost and environmental impact of CNG stepped in the foreground.CNG is a new technology of sea transportation of natural gas, with the ability to load gas directly from the field and unload them directly into the consumer network thus avoiding the expenses on construction of pipelines and LNG factories [7].

Conclusions

1. Liquefied gas is a environment-friendly and easy-to-control type of fuel used for cooking, heating, industry and motor vehicle fuelling.
2. CNG becomes a main type of fuel rather than an alternative. There are also motor vehicles which run on CNG only, like buses or vans.
3. R&D studies are limited in Russia, which does not match the potential benefits from CNG use in the future.
4. However, both types will be developing in the future in different fields of application despite all the advantages and disadvantages of CNG and LNG. CNG will be developing in passenger cars and light commercial vehicles with LNG still used in heavy machinery

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CONTAINERIZATION DEVELOPMENT IN RUSSIA TILL 2020

The paper deals with what have been done, what will be done and how will containerization develop in Russia.

Key words: *container, development, terminal*

Introduction

In the middle of last century Malcolm McLean, American truck magnate, has found a new way of transportation goods in "big boxes" now known as "containerization". This innovation reduced the time of cargo handling in ports; decreased the costs of transportation and made equipment standardized all over the world. The volume of container trade has been increasing for 8–10 % per year over decades. The main reasons of this growth were:

- development of world trade;
- development of sea trade, port's infrastructure and cargo handling equipment;
- need of door-to-door service.

Current situation

Nearly 50 % of Russian container trade takes part in Baltic Sea region. That is why new terminals are developed and updated there. A key player is the Global Ports Investment Company, whose terminals are located in the Baltic and Far East Basins, key regions for foreign trade cargo flows. Global Ports company operates five container terminals in Russia (Petrolesport, First Container Terminal, Ust-Luga Container Terminal and Moby Dick in St. Petersburg, VSC Company in the Vostochny Port) and two container terminals in Finland.

What is done and what shall be done

Some items of the Port Infrastructure Development Strategy of Russia for period till 2030were implemented and the other part is in progress. First, the new port Bronka opened in September of 2015. It can accommodate vessels with the capacity of up to 5 668 TEU. In current state the container terminal can handle 1,45 M TEUs per year. Port authorities are planning to increase throughput capacity up to 3 M TEUs per year. The container terminal in the port of Ust-Luga (ULCT) also has started its work. At full development ULCT will be the largest and the most technologically advanced facility in Russia and Eastern Europe of its kind, with depth alongside up to 16 m and throughput capacity of 2.6 M TEU. Beneficiary location, combined with the well-developed rail infrastructure, allows ULCT to offer most efficient delivery options to mainland Russia as compared to routes via neighboring countries. Now ULCT handles regular calls of Maersk Line, CMA CGM, Unifeeder, Hapag Lloyd and Team Lines. According to the mentioned Port's infrastructure development strategy, some other projects are under way now. There are plans to complete the construction of container terminal in Baltiysk with throughput capacity 400 000 TEUs/year. In Azov-Black Sea Basin container trade develops, too. The deep water container berth in Novorossiysk with throughput capacity 650 000 TEUs/year is to be built. In the sea port Taman two container terminals are being designed. They have to handle about 10 M tons per year.

Conclusion

Now ports of Baltic Sea basin have rather high throughput capacity, powerful cargo handling equipment, well- educated specialist, but they have another problem: lack of containerized cargo to handle. Embargo for many import cargoes severely affected national economy. For the 2015 year container turnover in the Baltic Sea basin ports decreased by 29.3 % (1,98 M TEU) and in all Russian ports by 25.4 % (3,944 M TEU).This shows that container trade in Russia depends of import cargo. The main export commodities are: oil, coal, ore, fertilizers, timber, steel. The half of them is being transported in bulk. That's why it is very important to attract and produce new cargo for export in containers. Not less important is to find new partners for import shipping. Being this done, the country will use the whole capacity of new container terminals and ports. In my opinion container trade in Russia just recovers for period till 2020. But then we can increase container turnover because we will have the adequate port facilities for it.

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THE PERSPECTIVES OF THE OIL TRANSPORTATION ALONG THE NORTHERN SEA ROUTE

The Northern Sea Route is of prime importance nowadays at the time when deep oil and gas fields were started to develop in the Arctic. The increasing tendency of transportations by the Northern Sea Route is showed in the article. In addition, it gives attention to the perspective projects of the oil-transportation companies in the Russian Arctic.

Key words: *The Northern Sea Route, the tanker transit, oil transportation*

Introduction

More than 20 % of the Russia's territory lies inside the Arctic Circle. On the coastal belt and on the arctic seas shelf 95 % of gas, 75 % of oil and in addition to this nickel, stannum, platinum-group metals, gold and diamonds are produced there. In whole, the petroleum potential of our country is estimated at 100 billion tons what consists approximately 30 % of the world gas and oil resources [5].

Oil transportation along the Northern Sea Route

Nowadays Arctic is discussed even in those countries where snow never falls. There are several reasons for that. It's developing Northern Sea Route, hydrocarbon production and atomic ice-breaker fleet [3]. Thanks for that Northern Sea Route (then NSR) at the first time allows to deliver hydrocarbon crude to the Atlantic and Pacific ocean shipping markets. Today the shipping from Europe to Asia and back along the high-latitude routes is economically advantageous. A number of days required for shipping and the distance between ports on the NSR is two times less than in transit thought the Panama or Suez canals (see the following table) [1].

According to Mintrans of Russia 36 voyages travelled through NSR for 2012th year what was equal to 1,2 million tons of cargo. In 2014 almost 3,98 million tons of cargo was transported [6]. In 2015 approximately 5,2 million tons of cargo was travelled by NSR where over half consisted of oil cargo.

The exploitation of new oil fields takes an important part in the development of oil transportation along the NSR.

As early as in the end of the 20th century the Prirazlomnaya oil field was opened. It is located on the Pechora Sea shelf, in 60 km from the coast (Varandey settlement). Currently it is the one functional oil production project on the Arctic shelf in Russia. The oil reserves of Prirazlomnaya field are over 70 million tons what allows to reach the point of 5,5 million tons of oil annually. In 2012 at one sweep three tankers "Varzuga", "Hatanga" and "Indigo" delivered diesel fuel oil for platform needs. And in 2013 in December the oil extraction was started.

The first crude oil run was loaded on tanker "Mikhail Ulyanov" with deadweight of 70 thousand tons. In 2014 around 300 thousand tons was produced and in 2015 that factor was increased in 2,5 times.

Table: Reducing of distances by using NSR (in miles)

Port of destination	Line of march	Port of departure	
		Murmansk	Rotterdam
Yokohama (Japan)	Suez Canal NSR	12 840 5 767	11 205 7 345
Shanghai (China)	SuezCanal NSR	11 999 6 501	10 521 8 079
Vancouver (Canada)	Panama canal NSR	9 710 5 406	8 917 6 985

The most important aspect in the development of Prirazlomnaya field was in November, 2015 when the first millionth ton of Russian arctic oil was produced [7].

In summer of 2014 the oil exports from Novoportovskoye field was begun [8]. An ocean-going tanker delivered materials in Europe in September and summary in the ice-free period of 2014 year more than 80 thousand tons was exported.

"From cob Stone in the Gulf of Ob around 100 thousand tons of oil was exported. Since February, 2015 oil export is continues. More than three tankers of Arc5 class have exported 48 thousand tons of oil. In future we are expecting roughly 5 million tons of export annually" – says Olga Buch, the general director of the Association of Arctic projects builders "Murmanshelf" [4].

In 2016 the full manufactured development of New port was started.

In addition to this, in 2018-2028 the producing of 3 million tons of oil annually is expected on the territory of Payakhskoye and North-Payakhskoye fields. Specially for that on the Tanalay cob the building of the oil export terminal is planned [3].

Concluding remarks

1. The purposes of our policy in the oil and gas industry became the development of raw materials base, transport infrastructure, increasing of the part of high-value products in the production and exportation of oil and gas. (As a result in 2020 the oil production have to increase for 545 million tons annually, export will take 255–265 million tons, oil refining will take 235–280 million tons);
2. Therefore, oil transportation along the NSR might become the most demanded world logistic march between Europe and Asia;
3. The government suppose that until 2020 year cargo turnover through NSR will be more than 50 million tons. However, the deposits for the port infrastructure development on the Arctic coast should be increased.

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LOGISTICS DELIVERY OF RUSSIAN EXPORT LUMBER

The report analyzed the current state of trade in products of the forest industry. For example, delivery of lumber from Russia to China shows the course of the development of the logistics supply chain options.

Key words: *international trade in lumber, alternative transportation*

Russia – the richest country in the world forest. It accounts for approximately 22 % of the planet's forest cover, half the world's reserves of softwood. It is projected that by 2020 global demand for commercial timber will increase by about 100 million cubic meters, and there is only one real source of her satisfaction – Russian stocks. They now make up more than 82 billion. Cubic meters.

Forests in the Russian occupied 45.3 % of the territory (Figure 1), which is higher than in Canada, Brazil, Yugoslavia, USA, Germany. Here Russia is second only to Japan, Finland, Angola, Zaire and Sweden (49 %).

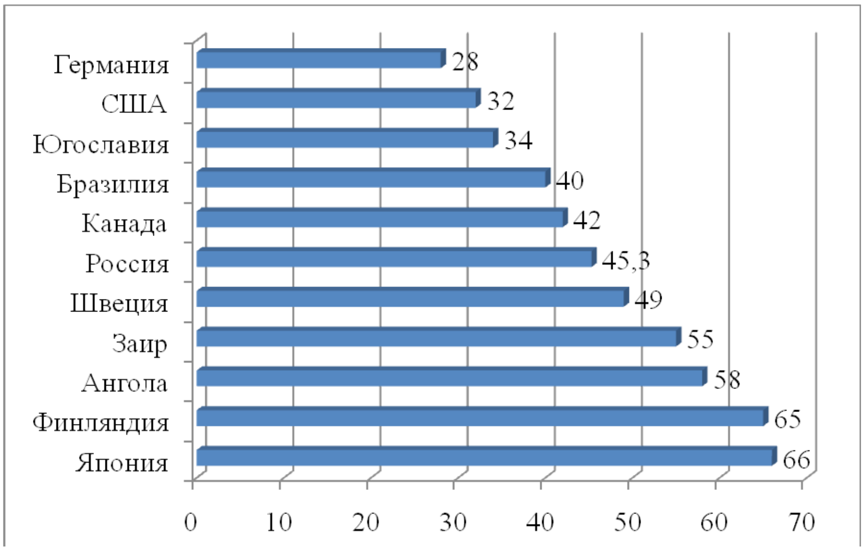

Fig. 1. The area of Russian forests of the total territory of the country, %

But in spite of this, Russia's share in world trade of timber accounts for only 4 %. At the same time more than half of the exports accounted for round timber and lumber (54 %). Forests cover more than half of the country, however, the forest sector's share in gross domestic product (GDP) was only 1.3 %, industrial production – 3.7 %, in employment – 1 %, and in the country of export currency revenues – 2.4 %. All these facts indicate that the huge potential of the country's forest significantly underutilized [1].

The peculiarity of Russian timber industry is that while the vast territory and poor transport infrastructure, most logging and wood processing companies much removed from users that determines the significance of transport costs in the economy of enterprises.

The relevance of this report due to the fact that today it is essential to organize the delivery of forest products to the end user, while reducing transportation costs.

Exports of forest has quite a large position in foreign trade activities of the Russian Federation, the average business. Sale of wood is carried out in more than 50 countries. The main share of exports accounted for the following ten countries: China, Egypt, Tajikistan, Uzbekistan, Syria, Germany, Iraq, Denmark, Kyrgyzstan, Azerbaijan. A significant share of Russian timber export of sawn timber transportation.

Lumber – is the product obtained by the longitudinal or tangential sawing wood. The history of their use of more than one century, because the tree is considered one of the most affordable and easy processing of natural materials. Today, thanks to modern technology, it was possible to achieve the highest quality of the final product and reduce its cost due to the almost complete absence of waste.

International trade in lumber is developing very dynamically. This is facilitated by the constant growth of world consumption of sawn timber in various sectors of the economy and an increase in the importance of wood as a natural, environmentally friendly material universal.

The Russian Federation has more than 10 thousand lumber producers. The domestic market is rapidly developing and has excellent prospects (Figure 2) [2].

Пиломатериалы (млн м³)

Показатели	2010*	2015	2020	2025	2030
Производство					
Инновационный	24.7	42.0	55.0	59.5	66.2
Умеренный	24.7	35.8	43.4	47.0	51.5
Инерционный	24.7	29.6	31.7	34.4	36.8
Экспорт					
Инновационный	17.7	18.6	21.1	22.6	26.3
Умеренный	17.7	19.0	19.9	22.4	24.9
Инерционный	17.7	19.5	20.8	22.8	24.5
Потребление					
Инновационный	7.1	23.5	34.0	37.0	40.0
Умеренный	7.1	16.9	23.6	24.7	26.7
Инерционный	7.1	10.2	11.0	11.7	12.4

* С учетом поправки на неформальную деятельность.

Fig. 2. Forecast of development of Russian market of lumber

An important direction of Russian lumber shipments in recent years China has become. Wood consumption in the People's Republic of China (PRC) has affected not only the interests of the Asia-Pacific region, but also in other countries of the world, particularly Russia [3].

Russian raw materials was the basis of the Chinese paper industry and housing construction. The demand for Russian wood is particularly acute for China due to the fact that since 1998 the country has a ban on the felling of forests, and therefore, in contrast to the growing demand potential domestic supply decreased significantly since then.

Therefore, today Russia - one of the largest suppliers of sawn timber to China. In the last twenty years, Russia was in the top three vendors, and recently came out on top.

It is believed that the four main reasons for the attractiveness of Russian timber for the Chinese consumer are as follows. Firstly, Russian timber mainly harvested forests natural origin, has high quality. Secondly, moderate price, even lower than in Chinese wood species and similar quality. Third, the forest reserves of high-quality hardwood such as Manchurian ash, Mongolian oak, in the Northeast of China nearly exhausted, and the Russian forest is a very good alternative. Finally, the fourth reason - is favorable border trade conditions which have arisen due to the transition to a market economy and liberalization of trade in both countries.

Timber imported from Russia to China by rail via Manzhouli crossing points, Erlian in the Inner Mongolia Autonomous Region and Suifenhe (Heilongjiang Province), as well as by sea. The main port, through which the supply of lumber from Russia, are Shanghai, Qingdao, Ningbo.

According to 2014 due to the high rates of housing construction lumber exports to China increased rapidly in this regard in 2015 was the increased demand for these products from China. At the same time, in the medium term can be expected to intensify the efforts of Russian companies for the production of sawn timber and increasing the share of processed timber imports from Russia to China.

Typically, the forest industry products sold major dealers in bulk and transported as bulk cargo in open wagons for rail freight, and bulk transport vessels at sea. But today the rare customer immediately takes a few thousand tons of lumber, so increasingly began to haul timber in small batches (up to 25 tones) in containers. Transportation of such goods as paper, lumber, metals, container and contributed to the growth of Russian export container traffic [4].

Due to the tightness of containers ensures high safety and security of shipping lumber, making such transport more attractive to the customer. Transportation of lumber are always associated with a special kind of difficulties, since it is much more complicated than the delivery of a domestic cargo, which is compactly packaged and prepared for shipment. Wood products (edged, lumber, plywood, chipboard, pulp, paper) have their own characteristics in the implementation of transport. These products should not be subject to any external environmental influences and mechanical stress in the implementation of overloads, so the transportation of sawn container is the best alternative to other forms of transportation.

To download lumber used mainly standard 40-foot containers and 40' High Cube (containers increased height) load-carrying capacity 26 – 30 tons. Loading is carried out under the control of the shipper, the container is sealed and intact and able to be delivered to the end user. Finally, the main advantage of container shipments – far more flexible logistics both in terms of size of party shipments, and geography.

So, lumber delivery from Russia to China can be arranged as follows: timber at the factory ship in containers or cargo is delivered to the terminal and there is repacking into a container, then the containers are sent to the nearest seaport, and then carried out the carriage by sea to the port in China; or the timber cargo in containers and shipped by rail to the Russian-Chinese transition, where the containers are transferred from one railway platform to another (because of the difference in the 1520 mm width and 1435 mm), and further followed by the Chinese railway to the point delivery.

Both methods are fundamentally different in that in the first embodiment, the foundation of maritime transport, and the second option is a completely ground transportation. Location China towards Russia allows you to use both the first and second ways, depending on the location of the manufacturing plant, the final customer and the logistics of the transport company.

Today transportation by sea transport is the most attractive (because of low transportation costs), but despite this, and rail transport is widely used in transportation. Thus, delivery of containers in China can be activated Trans-Siberian Railway, which now provides a powerful double-track electrified railway line length of about 10 thousand. Km, equipped with modern means of information and communication. Despite the high cost of tariffs for rail transportation of containers, highway may be the alternative to maritime transport, as shipping cargo on it is much faster.

Consider several options for delivery of sawn container on concrete examples.

For the point of departure plant for the production of lumber accepted in Russia JSC "Vyshnevolotsky LPH". A characteristic feature of the modern timber industry - focus on the external market of lumber. The final delivery point in China passed Shanghai. This port is a major, which is carried out through the delivery of lumber from Russia.

Due to the convenient location of the plant in relation to the city of St. Petersburg (only 410 km from the Vyshny Volochek) is considered the base case transport cargo delivery through the St. Petersburg port. This supply chain is as follows: At the factory, "Vyshnevolotsky LPH" comes loaded lumber tarp covered wagon. The cargo is delivered to the terminal in Shushary "Logistics" for repacking sawn container. Next, the container is sent to the port of St. Petersburg, where it is loaded on the vessel. Implemented by the carriage by sea to Shanghai line CSCL via the port of Hamburg.

The second delivery option can be considered through the Finnish port of Kotka. This version is based on the fact that often the goods, the recipient of which Russia, goes through Finnish ports. Lines are spending money on the return of import containers from Russia to Europe.

The idea of the supply chain is as follows: Finnish container is transported to Moscow or St. Petersburg, but the client is obliged to return the container to Finland. To carry the container is not empty, the client loads it carries cargo and exports, but not in St. Petersburg, and through the ports of Finland, thus realizing a return on the container line.

So, the famous line Hapag-Lloyd has a steady flow of imported cargo in containers (cargo "Center for Shoes" firms), which comes in Kotka. Then the cargo is delivered to Moscow at the warehouse of the company. Accordingly, on the return of these containers in Finland and based scheme from Moscow to the plant Vyshny Volochyok delivered car-container ship empty container line Hapag-Lloyd for loading export lumber. With a factory made road transport in the port of Kotka, where the container is loaded onto a ship and transported by sea to Shanghai line Hapag-Lloyd with transshipment in Hamburg. Through this "ring" the customer saves on the return of the empty container on the line and earn on exports.

A variant of delivery of lumber with a significant participation of the railway is to transport through the port of Vladivostok as follows.

In Moscow, there is a drain line Fesco containers. You can order a car-container with empty containers for stuffing the line at the plant in Vyshny Volochyok. The plant timber loaded into the container, which is sent to the M/A cargo station Inventories Kursk (Moscow). In the Trans-Siberian railway platform container delivered to the port of Vladivostok, where it is loaded on a ship and is carried out in the maritime transport line Shanghai Fesco.

As another transport option can be considered delivery of lumber through the port of Novorossiysk. The plant "Vyshnevolotsky LPH" comes loaded lumber tarp covered wagon. The cargo is delivered to the container terminal of the port of Novorossiysk "Novorossiysk sea trading port" for repacking sawn container. Further, in the port of the container is loaded onto a vessel. Sea transportation from Novorossiysk to Shanghai carries ZIM Line through the port of Istanbul.

In all previous versions in the delivery component of the present sea, but the location makes it possible to consider China delivery method only terrestrial means of transport: The factory Vyshny Volochyok tilt wagon loaded timber. The cargo is delivered to Moscow, where the repacking in a rented container terminal LLC "Rhenus – Yuzhny port" and loading containers on the railway platform. By rail cargo is up to the Russian-Chinese transition Zabaykalsk – Manchuria. The container is then reloaded onto another railway platform and sent to Shanghai.

Increasing the volume of lumber shipments from Russia due more to the relatively low prices. The quality is not inferior to European standards. But even this unquestionable advantage as price, may be lost, if properly organize the delivery. Our country has a huge territorial space, many paths and roads. . In Russia, 4 thousand railway stations, 87 thousand km of railways, 2 thousand berths in the rivers, 43 seaports, inland waterways length of 84 thousand km, the length of highways – 540 thousand km. Therefore, if there is such an extensive transportation system is very important to correctly and professionally to make transportation plan, to determine how best to deliver lumber.

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PRESENT CONDITION AND TRENDS OF DEVELOPMENT THE NORTHERN SEA ROUTE

This article presents modern condition of Northern Sea Route, prospects of development of icebreaker's fleet, measures impact headlong growth of capacity Euro-Asian transportations on its competitive abilities with Southern Sea Route.

Keywords: *the Northern Sea Route, transportations, icebreaker's fleet, transit.*

Introduction

In accordance with Federal act "On inland seas, territorial seas and contiguous zone of Russian Federation" (1998), the Northern Sea route is historically formed national integrated transport communication of Russian Federation in the Arctic [7].

The first project of marine route from the Ice cold sea to the mouth of Ob was composed by clerk Dmitry Gerasimov in 1525. The 17th century witnessed the beginning of many expeditions, Arctic seas and straits were explored. The flotilla of the Arctic Ocean was formed in 1916.

By the beginning of the Great Patriotic War the Northern Sea Route had been prepared for regular marine transfers and the passage of warships. However, the expeditions of the passage of warships occurred occasionally: 3 expeditions were in the prewar period and one was during the war.

In the Soviet period the development of the Arctic marine transport system considered as one of the evidences of the Arctic exploration strategies and effective means of implementing defense policy in the region. By the beginning of 90ths years of last century as a result of years of effort the well-developed system of the navigational hydrographical and hydrometeorological support was created which greatly increased the safety and carrying capacity of vessels in ice conditions. In addition to this, by the 60-year anniversary of the Northern Sea Route which was celebrated in 1992, 7 nuclear and 8 diesel line ice breakers, the nuclear light carrier "Northern Sea Route" and more than 130 transport vessels ice-class acted on this transport artery. The volume of transported cargo across the Northern Sea Route was more than 6 million tones per year, which was by 5 times exceeded the total annual cargo traffic in the Foreign Arctic.

As serious geopolitical loss estimated the impact of the weakening of our country in the Far North, occurred as a result of the disintegration of the Soviet Union. Despite the deterioration in the economic situation and decrease in financial possibilities of the budget, the Arctic stays a priority region for the implementation of government programs [6].

Present condition

The process of changeover to market relations is marked by transformation of parts of the NSR and central subjects into different forms of property.

The sea shipping companies except for Arctic were funded. The icebreaker, rescue and hydrographical fleet, port facilities, the net of Polar stations, navigational hydrographical and hydrometeorological support and communication facilities are consolidated in federal property. Icebreaker fleet was given to confidential management of JSK "Murmansk shipping company", JSK" Arkhangelsk shipping company" and JSK "Far-Eastern shipping company". However, a federal property of NSR and management is the base of keeping NSR as national communication of Russia in the Arctic.

The Arctic ports are still the most weakest part of NSR. Modernization of technical equipments of ports hasn't carried out because of lack of facilities from owners since 1990.Berthing facilities at most ports need capital repair, reconstruction and dredging for reception modern vessels.

Because of decreasing budget to 15–20 % from necessary capacity, navigation hydrographical support can't provide safety maritime traffic in all. Only minimum needed navigational facilities are introduced in action. In fact, the hydrographical fleet (21vessels) stopped systematic surveying work.

The navigational and warning of dangers transmission system has disorganized because of liquidation the net of radio stations.

Hydrometeorological support was significantly decreased both capacity and quality of icebreaker and meteorological forecasts on different deadlines. In consequence of lack of budget sponsorship the quantity of Polar stations has decreased 4 times since the end of 1980 [5].

Despite the losses incurred in the volume of freight traffic on the NSR (from 6.7 to 2.0 million tons per year or less), as part of a transport fleet of ice navigation in Arctic infrastructure created Arctic sea transport system provides a slimmed-down the country's needs in the Arctic freight.

As the positive moment it is possible to note creation of the center carrying out monitoring of an ice situation therefore quality of hydrometeorological providing has considerably improved.

In 2009 the design was finished and the construction of multipurpose rescue vessels and diving boats [6].

Transit transportation of cargo on the NSR which has been almost stopped since the beginning of the ninetieth years is restored. In 2010 the SCF Baltica tanker with deadweight 117 thousand tons, the ice class Arc5 (1A Super) belonging to group of companies Sovcomflot delivered on the Northern Sea Route 70 000 tons natural gas liquids for the Novatek company to China (the port Ningbo) from the ports Vitino and Murmansk. For the first time in the history such large vessel has passed across the Northern Sea Route. Voyage passed under conducting of nuclear ice breakers on the traditional route therefore the vessel has been loaded not completely to provide the draft through passage in regions of shallow waters(Sannikov Strait and other parts).It was an experimental voyage. Its duration was 22 days that almost twice quicker than traditional routes through the Suez Canal.

After tanker NORDIC BARENTS bulker with deadweight 44 thousand tons, the ice class Arc4 (1A) under flag of the Hong Kong, China, delivered iron-ore concentrate from Norway to China has proceeded the same way. On the Northern Sea Route the stage of the George Ots ferry from St. Petersburg to Vladivostok is carried out. The Monchegorsk container carrier (the ice class Arc7) belonging to Norilsk Nickel MMC has made commercial voyage from Dudinka to Shanghai and back. Some other vessels have passed on the route. Particularly on the December the nuclear icebreaker Russia has conducted from the east of Arctic to the west Sweden icebreaker vessel Tor Viking for 9 days having overcome about 2500 miles [8].

Prospects and directions of development

The aim of modernization Arctic model of maritime transport system – providing ensure and economically efficient transportation of increasing volumes of cargo for minimum duration, taking into account social, environmental, defensive and others national requirements [5].

In the last several years the tendency to increase the volume of maritime transportation was outlined. During 2005–2007 this volumes have exceeded 2 mln tons and go on increasing. According to data of Ministry of Transport, for 2007 across the Northern Sea Route there have passed 2 voyages, for the 2008th – 3, for the 2009th – 5, for the 2010th – 10, for the 2011th – 41, for 2012 – 36 voyages (from them 25 vessels with cargo, 11 – with ballast). In total for 2011 across the Northern Sea Route about 835 thousand tons of cargo has been transported in transit, in 2012 – 1,2 mln tons of cargo. At the same time in 2012 for the first time in the history tanker Ob River, width 45 meters, with 145 thousand cubic meters liquefied natural gas has passed across the Northern Sea Route. However, despite the obvious trend to peak traffic, both in the distant 80-ies of the last century, it is still far. Modernization of coast navigational facilities is carried out. Since September of 2012 the whole Northern Sea Route has been covered by the net of the control correcting stations GLONASS/GPS [3].

Provision of national interests of Russian Federation as for the Northern Sea Route is one of the top issues. In 2012 the law "About modification of separate acts of the Russian Federation regarding state regulation of trade navigation in the water area of the Northern Sea Route". Codification of water space on which route passes our country undertakes serious international obligations. Vessel under any flag is guaranteed the traffic safety, the icebreaker and pilot convoy, the help in extreme situation, the right to use coastal infrastructure. In the law environmental protection of Arctic especially makes reservation. For sailing on the Northern Sea Route from ship-owner or freighter it needs financial support on a case of possible damage of region environment. As a result the Northern Sea Route gets not just a center of management, but the program of development. Administration of the Northern Sea Route – government entity created for execution of the law, – besides organization of navigation and control for its will keep monitoring of hydrometeorological, ice and navigational situation, compose appropriate routes, qualify pilots, coordinate searching and rescue operations, watch for cleaning entrusted water area.

Settlement of the Northern Sea Route will start with construction of new stations and appointments of supervision, centers of extra reaction on signals of distress.

At the same time, in the conditions of strained international competition in fight for resources of Arctic shelf the meaning of Russian nuclear icebreaker fleet increases. Nowadays on ways of the Northern Sea Route 9 line icebreakers works, from them 5 nuclear of which built in 2007 50 years of Victory nuclear icebreaker and 4 diesel-powered. The development of the icebreaker fleet of Russia goes within federal objective program “Development of Russian transport system (2010–2015 years)”. So, laying of icebreaker with a power of 25 MW at the Baltic plant and icebreaker with a power of 16MW at Vyborg shipyard has been taken in 2012. In 2013 Rosatom declared about holding two open contests for construction commercial universal nuclear icebreakers of project 22 220. Construction of both icebreakers will hold 5 years, the first – from January 2014 to December 2019, the second – from January 2015 to December 2020 [3].

Due to the rapid economic development of the Asia – Pacific region, of the Northern Sea Route can bring considerable revenues to the Russian budget. The Northern Sea Route allows to realize transportation 1,5 times quicker than traditional route through overload the Suez Canal. The length gone by vessel from the port of Murmansk to the port of Yokohama(Japan) through the Suez Canal which composes of 12 480nautical miles while the Northern Sea Route – 5770 miles. The way through the Northern Sea Route in comparison with way through the Suez Canal is shorter by 2440 nautical miles and reduces the duration of the voyage for 10 days and, besides this, saves a large amount of fuel – about 800 tons for the average vessel.

Characterizing transit potential of our country, it should be noted that transit of Russian railway can reduce the time of delivering cargo almost 3 times, but it promises serious profits for many countries. For this purpose it is necessary to increase competitiveness of the Trans-Siberian Railway and to attract foreign consignors in transit transportations on the route of the Northern Sea Route.

Attraction of foreign partners and investors for development northern transport artery became one of the key themes of lasted on APEC summit in Vladivostok in 2012. During the summit parts discussed possibilities of multilateral partnership in development of Northern Sea Route. The participants came from the fact that in the near future, due to the rapid increase in the volume of Euro-Asian transportation, the Northern Sea Route will be able to successfully compete with the Southern Sea Route.

So the development of the Northern Sea Route is able to give powerful impulse for development not only Far East and Northern region of Russian Federation but economy of country in general.

The predicted effects of global warming and the prospects for pirate attacks on ships, following the southern routes , increase the interest of ship-owners to the Arctic routes. However, the Northern Sea Route will be able to compete with the southern routes only on the condition that it will be cost effective and its infrastructure will provide the maximum reduction of additional risks in navigating in the Arctic ice [6].

In the Government of Russia the Complex project of development of the Northern Sea Route is approved. Implementation of an integrated project will ensure the safety of navigation, operation of ships and vessels of the Navy , northern delivery in the subjects of the Federation, located in the Far North and the protection of the marine environment from pollution , as well as increase the reliability of transit and transportation of hydrocarbons from the mining sites located on the Arctic coast and the continental shelf of the Russian Federation. Term of implementation of the Complex project – 2015–2030 years [4].

Conclusion

Generally, the Northern Sea Route is the base of the economic stability of the North of Russia and the most important element of Russian and international transport system. Its potential is very large but it can be implemented during decades of an active development and requires permanent financial support.

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TRENDS IN DEVELOPMENT OF CONTAINER SHIP

General information about container transportations is considered in this article: the history, characteristics of container ships, advantages and disadvantages of transportation by this type of transport. Trends in development of container ships, on the basis of comparison of ships of different years of construction are analyzed. The current state of container fleet for February, 2016 is stated in article.

Keywords: *containers, container ships, container transportations, current state of container fleet, trends in development.*

Introduction

Transport is part of economic activity.

The main direction in technology and the organization of transportation of cargoes by the sea is the containerization of transportation process. Now about 80 % of general cargoes are transported in containers.

Around the world large-capacity container ships are actively used. It promotes expansion of the market of transportations and nomenclatures of the transported cargoes.

History

Throughout several centuries the international cargo transportation plays a major role in world economy.

In the thirties the XX centuries the brilliant idea has come to American Malcolm McLean, the owner of the small transport company bringing to local port cotton for loading on ships – not to load separate bags or boxes, and to think up a way of loading at once of all volume of the delivered cargo [7].

Then the idea of transportation of containers – not just creation of standard steel boxes, but creation of the container ship, and the automobile container platform working on uniform conditions has also been conceived.

At once it wasn't succeeded to embody idea. But nevertheless, having shown persistence and having bought small shipping company McLean sent the first cargo with 58 containers from Newark to Houston, on April 26, 1956 by own ship "Ideal X" remade according to McLean's drawings [7].

This bright example also became a starting point in creation of container transportations. Business has moved off dead point as the multimodal transportations demanding frequent change of transport just gained strength, and the uniform standard of the container fine reduced time for transfer as the vast majority of freights had been brought by pile.

The first flight delivering a large consignment of explosive to Vietnam has shown tremendous efficiency of the similar organization – time expenditure was reduced by 500 %, and efficiency of deliveries has increased for 600 % in comparison with deliveries pile. In parallel with military deliveries McLean has organized transportations of the equipment to the Southeast Asian countries, and by the end of war of 80 % of all cargo traffic in this region was carried out by means of containers [7].

Advantages and disadvantages

Today container transportation of cargoes is the main form in sea transportations of goods [1]. There is no wonder, with their help it was succeeded to expand and formalize possibilities of sea transportation of cargoes considerably.

Advantages of transportation of cargoes in containers [5]:

- Well freight remains;
- There is no need to overload goods when changing a type of transport;
- The goods once will be loaded into the container at the sender and unloaded at the recipient in a warehouse;
- Less costs of a container for goods are required;
- Rates of loading and unloading works accelerate;
- As a result, delivery periods of freights decrease;
- Process of delivery of cargo to the recipient's warehouse has become simpler;
- Transport documentation and forwarding operations has become simpler and unified;
- There were more opportunities for a computerization of management of process of cargo delivery.

Disadvantages of transportation of cargoes of containers [5]:

- Transportation speed by sea is quite low;
- The type of containers is limited.

The main lack of containers – need of their return. Return of empty containers which didn't manage to be borrowed with the return freight means. On average 15 % of total of the containers transported by the ship are the share of these returns. Obviously, it is additional expenses. But minuses are with interest blocked by benefits, as has caused triumphal procession of a containerization.

Modern situation

The cumulative container fleet as of February 15, 2016 contains 6084 ships with a capacity of 20.4 million TEU. The top ten of the largest carriers operates with 2515 container ships with a capacity of 12 million TEU. Maersk Line headed rating, on the second place – MSC, on the third – CMA CGM. The fourth place is taken by Evergreen [4].

Trends in development

To understand what the modern container fleet aspires to, it is necessary to compare characteristics of several container ships. For this purpose we will take two the largest, everyone in the time, ships with a construction difference in 9 years.

The biggest is the *"MSC Oscar"* container ship constructed in South Korea on shipyard today – *Daewoo Shipbuilding and Marine Engineering* in the city of Okpo. The Italian-Swiss company *Mediterranean Shipping Company (MSC)* has acted as the customer of the ship. On January 25, 2015 *"MSC Oscar"* left in the first commercial flight the Chinese port of Dalian [3].

The capacity of *"MSC Oscar"* – 19 224 TEU. Length – 395.4 m, width – 59 m, draft – 13,9 m. Gross tonnage – 193 000 grt, deadweight – 197 362 t [8].

It is provided that 1800 containers can be refrigerator – there is an opportunity to connect them to the ship power supply network [3].

The container ship is equipped with fuel-efficient engines for which modern oils of production of the Russian company *"Lukoil"* have been chosen [3].

"MSC Oscar" goes under the Panama flag and serves the line China – Europe. He is the head of a series from three container ships.

In 2006 in Denmark on shipyard of *Lindoe* was constructed the judgment container ship *"Emma Mærsk"* belonging to the Danish company *A.P. Moller-Maersk Group* [6]. At the time of construction of *"Emma Mærsk"* was the world's largest container ship.

The ship is called by the owner of shipbuilding company Arnold Merskom McKinney Moeller in honor of his late wife Emma (1913–2005) [2].

"Emma Mærsk" can transport to 11 000 TEU. Length – 396.84 m, width – 63.1 m, draft – 13.7 m. Gross tonnage – 170 794 grt, deadweight – 156907 t [9].

Creators, at construction of this transport ship, have established new standards in environment protection and safety, and also profitability that it is so important when transporting various freights. Treat them system of recirculation of exhaust gases that has allowed to reduce emission of harmful substances in the atmosphere and as a result, the power of the power plant has increased, and fuel consumption has decreased. The ship case processed by a special silicone covering that has led to unexpected result – due to reduction of resistance of water became one more innovation, costs of fuel have decreased by 1200 tons year [6].

The ship plies on the route between Southeast Asia (Ningbo, Yangshan) – the Suez Canal – Europe (Rotterdam, Bremerhaven) – the Baltic Sea (Gdansk).

The first container ship *"Ideal X"* could carry only 58 containers [7]. Modern container ship can take aboard up to 19 000 standard 20-foot containers. In 60 years their capacity has increased by 330 times. Also their linear sizes increase. It is possible to tell that development of container ships is reduced to the Olympic motto "Quicker, Above, More Strongly!"

Conclusions

In the future sea container transportations will play the increasing and big role in development of economy. Dimensions of containers have to project in the direction of standardization and an intensification. Eco-friendly shipping develop. At the heart of economy of resources new technologies will be developed, the organizational and economic forms of government will be improved by container transportations. Introduction of new modern technologies with use of the principles of logistics is to necessary conditions for container transportation of cargo. Introduction of information technologies will help to reduce time of delivery of containers, and also to cut the accompanying expenses and to increase competitiveness of the enterprises in sea container transportations. It will help to move to the new, more technological perfect level of work, not only will increase the income in the transport market, but also will increase quality of work and interaction of different types of transport.

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TRENDS IN THE DEVELOPMENT OF OIL TANKERS

This article discusses the history of the development of oil tankers, the trend of development, the size and category of modern tankers, environmental impacts of oil spills, prevention of oil spills and spill response procedures, double hulls are a key component of the oil spill prevention system.

Key words: *history of development, oil pipelines and tankers, size and categories of oil tankers, current architecture, hull designs, inert gas system, loading cargo, environmental impacts, prevention, double hull*

Introduction

Relevance of the topic. Currently, due to the increase of oil production, increasing exports and internal consumption of oil and oil products is an issue on how to further develop their transport. Therefore, in this article I want to examine trends in the development of oil tankers.

Petroleum, in one form or another, has been used since ancient times, and is now important across society, including in economy, politics and technology. The rise in importance was due to the invention of the internal combustion engine, the rise in commercial aviation, and the importance of petroleum to industrial organic chemistry, particularly the synthesis of plastics, fertilizers, solvents, adhesives and pesticides.

Trends in development

More than 4000 years ago, according to Herodotus and Diodorus Siculus, oil was used in the construction of the walls and towers of Babylon.

The technology of oil transportation has evolved alongside the oil industry. Previously, oil was transported in barrels and wineskins, but it was too expensive. Scientists and oilmen began to look for new, more effective ways of transporting oil. In Russia the main mode of transportation is oil pipeline transport [1], but in the world oil is transported by tankers and supertankers.

An oil tanker, also known as a petroleum tanker, is a merchant ship designed for the bulk transport of oil. There are two basic types of oil tankers: the crude tanker and the product carriers. Crude tankers move large quantities of unrefined crude oil from its point of extraction to refineries. Product tankers, generally much smaller, are designed to move refined products from refineries to points near consuming markets [2]. They also can be classified by their sizes. The biggest oil tanker ever is Jahre Viking. The vessel changed her name many times. Now this vessel is called «Knock Nevis».

The basic architecture of modern oil tanker was developed in the period from 1877 to 1885. In 1876, Ludvig and Robert Nobel, brothers of Alfred Nobel, founded

Branobel (short for Brothers Nobel) in Baku, Azerbaijan. It was, during the late 19th century, one of the largest oil companies in the world [6].

The Swedish Ludwig and Robert Noble designed the 1870s biggest oil tanker. The tanker was constructed in 1878 and her name was Zoroaster. The biggest oil tanker of that time carried the oil into two iron tanks and had capacity of 242 long tons. She was 184 feet long, her beam was 27 ft and 9 ft draft. The next big step in the industry was in 1883. The biggest oil tankers were designed with several oil holds.

The first tankers with this systems were the Lumen, Lux and Blesk. The first "modern" oil tanker also was Colonel Henry F. Swan design. The Glückaufwas built in 1986 and was the pioneer of the technology of pumping the oil directly into the ship's hull. There was no longer barrels or drums loading.

The World War I was the reason for the developing larger ships. The ships had to be bigger to carry more oil for the warships. The USS Maumee, built in 1915, was the first "underway replenishment technique" ship.

The biggest oil tankers took major part in the Second World War too. The most popular tanker was the T2-SE-A1. The biggest oil tanker of that time had a capacity of 16,613 DWT.

The end of the World War II did not stop the growth of the oil tankers sizes. The biggest oil tanker in that time was the Bulkpetrol. She was built in the end of the 1940s and had capacity of 30,000 long tons.

The biggest oil tankers were built in the 1970s after the 1973 oil crisis. The biggest oil tanker and biggest ship ever constructed – Seawise Giant was built in 1979.

Size and categories of oil tankers: currently the tankers are categorized according to flexible market scale. The scale is base on deadweight metric tons. The biggest oil tankers in service currently are the TI Class.

Oil tankers usually have 8 to 12 tanks. Every one of these tanks is split into independent compartments by fore and aft bulkheads. The tanks are assigned numbers with tank one being the forward most. Their tank number and position, like «one port or three starboard», refer individual compartments.

The design of the hull and outer structure is a major component of tanker architecture. Single-hulled tankers have a single outer shell between the cargo and the ocean. Most newer tankers are double-hulled, with an extra space between the hull and storage tanks. The hybrid designs like double-bottom and double-sided use aspects of single-hull and double-hull tanker designs.

All single-hull tankers are expected to be phased out by 2026, in accordance with the International Convention for the Prevention of Pollution from Ships.

In 1998 a survey of industry experts was conducted by the Marine Board of the National Academy of Science, regarding the pros and cons of double-hull tanker design [7]. The advantages mentioned in the survey include:

- ease of ballasting in emergency situations,
- reduced practice of saltwater ballasting in cargo tanks decreases corrosion,
- increased environmental protection,
- cargo discharge is quicker, more complete and easier,
- tank washing is more efficient, and
- better protection in low-impact collisions and grounding.

The same survey listed the following as disadvantages to the double-hull design:
- more expensive to build,
- more expensive canal and port expenses,
- ballast tank ventilation difficult,
- ballast tanks need continual monitoring and maintenance,
- increased transverse free surface,
- more surfaces to maintain,
- explosion risk if vapor detection system not fitted,
- cleaning mud from ballast spaces a bigger problem.

Generally, double-hulled tankers are much safer than single-hulled in the scenario of grounding incident, especially is the shore is not very rocky. The safety benefits are smaller on larger tankers and in the cases of high-speed impact.

Most commonly associated with ship pollution are oil spills. While less frequent than the pollution that occurs from daily operations, oil spills have devastating effects. While being toxic to marine life, polycyclic aromatic hydrocarbons (PAHs), the components in crude oil, are very difficult to clean up, and last for years in the sediment and marine environment. Marine species constantly exposed to PAHs can exhibit developmental problems, susceptibility to disease, and abnormal reproductive cycles. One of the more widely known spills was the Exxon Valdez incident in Alaska. The ship ran aground and dumped a massive amount of oil into the ocean in March 1989 [3]. Despite efforts of scientists, managers and volunteers, over 400,000 seabirds, about 1,000 sea otters, and immense numbers of fish were killed [8].

Environmental Impacts of oil spills:

A tanker spill would adversely impact the environment:
- Threats to endangered and rare species;
- Damage to or loss of habitats;
- Population declines, particularly in top predators and long-lived species;
- Transformation of natural landscapes.

A spill would also have the following impacts:
- Negative effects on human health, well-being, or quality of life;
- Shrinkage in the economy and unemployment;
- Detrimental changes in land and resource use by our communities; and
- Loss or serious damage to commercial species and resources.

Cleanup and recovery from an oil spill is difficult and depends upon many factors, including the type of oil spilled, the temperature of the water (affecting evaporation and biodegradation), and the types of shorelines and beaches involved.

Prevention of oil spills includes [9]:

- Secondary containment – methods to prevent releases of oil or hydrocarbons into environment.
- Double-hulling - build double hulls into vessels, which reduces the risk and severity of a spill in case of a collision or grounding. Existing single-hull vessels can also be rebuilt to have a double hull.
- Thick-hulled railroad transport tanks.

Spill response procedures should include elements such as [10]:

- A listing of appropriate protective clothing, safety equipment, and cleanup materials required for spill cleanup (gloves, respirators, etc.) and an explanation of their proper use;
- Appropriate evacuation zones and procedures;
- Availability of fire suppression equipment;
- Disposal containers for spill cleanup materials; and
- The first aid procedures that might be required.

A number of manufacturers have embraced oil tankers with a double hull because it strengthens the hull of ships, reducing the likelihood of oil disasters in low-impact collisions and groundings over single-hull ships. They reduce the likelihood of leaks occurring at low speed impacts in port areas when the ship is under pilotage. Research of impact damage of ships has revealed [10] that double-hulled tankers are unlikely to perforate both hulls in a collision, preventing oil from seeping out.

Although double-hulled tankers reduce the likelihood of ships grazing rocks and creating holes in the hull, a double hull does not protect against major, high-energy collisions or groundings which cause the majority of oil pollution [10].

Conclusion

Double hulls by no means eliminate the possibility of the hulls breaking apart. Due to the air space between the hulls, there is also a potential problem with volatile gases seeping out through worn areas of the internal hull, increasing the risk of an explosion.

Despite documented issues with double hull tanker design, construction, operations, and maintenance, the double hull is generally accepted to provide a reduction in overall spill risk compared to single hull tankers. However, double hulls do not guarantee that no oil will be spilled. The potential for a catastrophic oil spill from a double hull tanker is real, and the consequences could be just as damaging as major oil spills from single hull carriers.

Double hulls are a key component of the oil spill prevention system, but they are not the only component. The only way to safeguard against the potential for future oil spills from double hull tankers is to create and maintain an effective prevention system that provides multi-layered against oil spills and accidents, including engineering and human factor components.

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NORTHERN SEA ROUTE

This article analyzes the prospects for the development of navigation in the polar regions of the Russian Federation
Keywords: *Northern Sea Route, sea, cargo, waterway.*

Northern Sea Route is the shortest sea way between the European part of Russia and the Far East.

The Northern Sea Route (historically North-East pass) is the main sea artery of Russia in the Arctic. it passes across the Arctic Ocean Seas, connecting European and Far East ports. The Northern Sea Route serves the ports of the Arctic and the large rivers. Fuel, equipment, food, wood and natural minerals are delivered here by waterway.

The key ports of the Northern Sea Route are Arkhangelsk, Dudinka, Garka, Tiksi, Ambarchik, Pevek, Bukhta Provideniya, Anadyr, Petropavlovsk-Kamchatsky, Vladivostok, Murmansk, Dickson, Nordvik.

These maritime routes pass across the seas of Arctic Ocean (Karskoye, Laptev, East Siberian, Chukchi) and partially Pacific Ocean (Beringovo). Administratively the Northern Sea Route is limited to the north by Cape Zhelaniya, and in the east by the Bering Strait.

Length of the Northern Sea Route from Kara Strait to Providence Bay is about 5600 km, or 3023.76 nautical miles. The distance from St. Petersburg to Vladivostok across the Northern Sea Route is over 14 thousand km in comparison with the distance through the Suez Canal which exceeds distance more than 23 thousand km

Alternative to the Northern Sea Route the transport arteries exist that pass through Suez or Panama channels. If the distance passed by ships from the port of Murmansk to the port Yokohama (Japan) through the Suez Canal, is 12,840 nautical miles, then the Northern Sea Route has only 5770 nautical miles.

Organizationally the Northern Sea Route is divided by:

- the West sector of the Arctic – from Murmansk to Dudinka, is served by ice breakers of Rosatomflot.
- the East sector of the Arctic – from Dudinka to Chukotka, is served by ice breakers of Far East Shipping Company.

IT has great influence on development of the Russian Far North. The numerous rivers flowing into the Arctic Ocean form uniform transport system which serves as the main industrial complex of the Arctic and subarctic regions in the Northern Sea Route. The mining, metallurgical and chemical complex of the Kola Peninsula, the West Siberian oil and gas complex, the Norilsk industrial region, a mining industry of Yakutia, etc. can be examples.

North-East pass was for the first time passed from the West to the East (with one wintering in a way) in 1878–1879 by the Swedish expedition of Niels Adolf Eric

Nordensheld. For the first time for a single navigation the Northern Sea Route was passed in 1932 by the Soviet expedition of Otto Yulyevich Schmidt.

The operation of the Northern Sea Route was begun in 1935 systematically. Before the war the problem of its transformation into the operating water highway providing systematic communication with the Far East was solved. This task was carried out by northern shipping companies, icebreaking fleet, polar aircraft, river transport, the Arctic ports and polar stations.

In 1935–1940 across the Northern Sea Route 2,5 million tons of freights – more, than for the whole history of the Arctic shipping were taken!

In post-war years annual goods turnover of the Northern Sea Route has increased by several times. The Arctic fleet was replenished with powerful diesel ice breakers, and then with the atomic-powered vessels capable to carry out vessels through long-term ices. For example, the nuclear Russian ice breaker without stopping moves in 2,5 meters thick ice. It has become a record – a 13-meter barrier at the settlement of Pevek.

The development of the Northern Sea Route was reached in 1970−1980. The volume of transportations raised from 4 million tons these years to 6.6 million tons. At the same time the Head department of the Northern Sea Route – Glavsevmorput was created, and in 1971 the Administration of the Northern Sea Route at the Ministry of Navy of the USSR which since 1992 has been in structure of Department of sea transport of the Russian Federation was founded.

Today the ships cross the Northern Sea Route from the West to the East annually and regularly. The network of polar stations has been increased, the Arctic ports are RECONSTRUCTED. The system of the drifting automatic radio meteorological stations is installed. Thanks to the appearing of nuclear "Arctic" ice breakers, navigation across the Northern Sea Route has been prolonged for 2–2,5 months, and in the western sector has become year-round.

The North Sea way is the only optimum way of delivery in the Polar region. It solves the following problems:

- considerable decrease in time for the trip (in comparison with South paths by sea);
- there is no payment for a pass of a sea vessel (only icebreaking collecting);
- no restrictions for the vessel size are imposed;
- the possibility of attack of pirates is completely excluded/

Proceeding from domestic and international experience, most of experts believe that the icebreaking fleet must be kept by the federal budget. It is necessary to study offers on transfer of icebreaking fleet to shipping companies – to joint-stock companies for long-term rent.

The state gives the main financial support of construction and modernization of icebreaking, transport and other fleet, and also reconstruction of the main ports, attracting investors to this purpose. Due to the forthcoming large-scale transportations of power raw materials from the Arctic districts it is necessary to provide the creation of large-capacity icebreaking and transport tankers for crude oil, gas carriers for the liquefied gases and bulkers ore carriers.

For improvement of annual delivery of the food, fuel and materials to subpolar regions, and also transportations of the geological and extracting equipment for investigation and arrangement of mineral deposits it is necessary to create specialized vessels with progressive technology of cargo processing. It is expedient to study and develop already available experience of usage of submarines, including nuclear, in the transport mode for cargo delivery, mainly food, in hard-to-reach spots of the Arctic in difficult ice conditions, and also for investigation and development of underwater offshore fields of minerals.

Navigation and hydro-meteorological and hydrographic services continue to be financed fully from the state budget. Monitoring of an ice cover has to include satellite and aviation means.

Soon it is necessary to prepare and adopt the law on preferable conditions of sailing on the Northern Sea Route for domestic fleet to provide approximately 70 % of freights transported the Russian vessels and 30 % by the foreign ones.

The Northern Sea Route is the main thoroughfare in the north of Russia. that works in difficult climatic and ecological conditions and has huge economic, political and strategic value. And its problems are tasks of the Security council and Ministry of Emergency Situations of the Russian Federation along with other departments.

The head of the government of Russia Dmitry Medvedev signed the complex project of the development of the Northern Sea Route. According to "Interfax", the prime minister noted that earlier the usage of this route was much better. According to Medvedev, "it has to work for realization of our transport and logistic advantages".

The Deputy Prime Minister Arkady Dvorkovich declared that in 15 years the volume of transportations across the Northern Sea Route can grow by 20 times. Now it makes a little more than 4 million tons per year. "Potential for the period in 15 years it is more than 80 million tons per year", – Dvorkovich told.

On the round table the following strategic subjects have been touched:

- assessment of drivers of development and growth of potential freight traffic;
- a role of the Arkhangelsk and Murmansk ports in development of the Northern Sea Route;
- prospects of innovative development of coastal territories of the Russian Arctic;
- problems of development of infrastructure of the Northern Sea Route.

At the same time a main object of the round table was the development of offers for formation of a state policy on development of the Northern Sea Route.

In strategy of social and economic development of the Northwest federal district for the period till 2020 one of the main directions of development of a transport complex of the region the need of development of all types a trance – port and terminal and warehouse infrastructure which helps development of large transport hubs as St. Petersburg, Murmansk, Vologda, Arkhangelsk and Kaliningrad, is noted. Here the main actions are noted: modernization and construction of port terminals on transfer of coal, containers, oil and oil products within the "Complex Development of the Murmansk Transport Hub" project; design and construction of the passenger terminal on processing of ferries and cruise ships in the port of Murmansk; construction of the seaport in Belomorsk where 2 cargo areas will appear – a specialized coal complex and a universal complex; development of the Northern Sea Route and infrastructure of the Arctic ports; reconstruction and construction of facilities of infrastructure in seaport

Arkhangelsk; creation of rear infrastructure of ports, including container terminals, customs warehouses and logistics centers.

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BERTH ALLOCATION OPTIMIZATION PROBLEM

The analysis of existing methods of modeling works a container terminal in the national and foreign literature. Proposed the foreign method – Berth allocation problem.
Key words: *container terminal, logistics, optimization, simulation*

Since the introduction of containers in the early 50^{th} development of the maritime transport was stunning. Since 1990, the number of container transport has increased fivefold. This success is largely based on the international standard container size. Useful volume of standard container of 20 feet and width of 8 feet length equivalent to one twenty-foot equivalent units (TEUs). It is estimated that the global number of containers more than 23 million TEUs. In 2007, container traffic amounted to 1.24 billion from 8.02 billion tons of cargo transportation of cargo, an increase of 4.8 % compared with the previous year.

The current stage of transport development is characterized by a worldwide spread of a progressive method of unification of packages, called "container revolution". Any cargo is placed in a standard container, transported by any route and in any combination of water and land transport modes. At the same time is reduced and intensified loading and unloading operations, the timing of the movement of goods, saving manpower and rolling stock. Significantly increases the safety of cargo during transportation and easier coordination of joint work of the sea, river, rail and road transport. The level of containerization of cargo traffic in the world is an average of 50–60 %. The process of containerization of cargo flows in Russia lags behind the world level, but is also characterized by stable positive dynamics. Worldwide, container terminals have a capacity of 485 million TEUs, nearly half of the world's container traffic handled 20 major terminals.

On the other hand, the capacities of most existing ports of extensive growth have been exhausted, as they are surrounded by dense urban infrastructure. Thus, in order to enable them to cope with the increasing flow of vessels need to optimize the existing techniques and solutions which are used on terminals. Such results can be achieved by increasing the intensity of the loading operations and minimizing terms of cargo handling. The most important and difficult task is to optimize the processing of ships by optimal planning and operational management of these processes.

Currently ships to describe processing in most cases using deterministic models are generally based on the assumption that the arrival of ships in port is a regular flow of events, following on schedule one by one at regular intervals. However, in actual arrival process of vessels to berths is random. Therefore, the use of deterministic models to describe the ships processing introduces significant error that prevents the use of these models to solve optimization of these processes. Gnedenko [1, 2] for the first time proposed to use to solve the problem of searching optimal characteristics transshipment terminal queuing theory. However, a technique developed by him takes into account the specifics of processing of various types of cargoes and do not allow adequately describe the operation of the container terminal.

To reduce errors also used probabilistic models based on the classical queuing theory systems. Such models were outlined in papers A.L. Kuznetsov' [3] for handling export-import ships and A.M. Tyukavin' [4] for processing coasters. However, this approach is not always expedient to use because it with insufficient accuracy describes a refining process of containerized cargo.

So when using a Markov models of queuing theory assumed that the duration of the transition of the vessel from port to port and duration of the processing vessel is subject to exponential distribution law. The adoption of these assumptions can lead to very significant errors in the calculation of indicators of quality of handling container ships in the stationary mode. A more rational in the case of short-term, weekly settlement is the berth allocation optimization problem.

The allocation problem of berths of container terminal can be described as a problem of distribution of berthing space for ships. As berth space is very limited at most container terminals, and thousands of containers must be handled daily, an effective berth allocation is critical to the efficient management of the container flow. The BAP is recognized as one of the major container terminal optimization problems in Steenken et all [5].

The problem has two planning/control levels: the strategic/tactical, and the operational. At the strategic/tactical level the number and length of berths/quays that should be available at the port to service the anticipated traffic are determined. At the operational level, the allocation of berthing space to a set of vessels scheduled to call at the port within a few days time horizon has to be decided upon.

Although, initially queuing approaches were used to model the BAP (Edmond and Maggs, 1978), at the operational level the BAP is typically formulated as combinatorial optimization problem (i.e. machine scheduling problem, 2D packaging problem). Several berth allocation models have appeared in the literature, differing in the assumptions made, the mathematical formulation, and solution approach. Usually, the formulation of the problem leads to NP-hard or NP-complete problems requiring the use of heuristics and meta-heuristics to obtain solutions in a computationally acceptable time.

The BAP can be modeled as a discrete problem where the quay is viewed as a finite set of berths, each serving one vessel at a time, or scheduling problem, where a vessel is treated as a job and a berth as a machine, whereas in the continuous case as a packaging or the two dimensional cutting stock problem, where one dimension is time and the other the size of the vessels.

Thus berths allocation problem can be represented in a two-dimensional space. One dimension is spatial, i.e. the quay length, while the other is a temporal decision horizon, which is often one week. Ships can be represented as rectangles whose dimensions are as a continuous problem where vessels can berth anywhere along the quay. In the discrete case, the BAP can be modeled as an unrelated parallel machine-length and handling time. The handling time is defined to be the time the ship is at the berth, whereas the service time is the total time the ship spends at the port (i.e. the handling time plus any waiting time the ship experiences as a result of not being

Figure 1 - The representation of the berth-time space

immediately serviced on arrival). These rectangles must be placed in the decision space without overlapping each other such that the length of the quay and the decision horizon are not violated (see Figure 1).

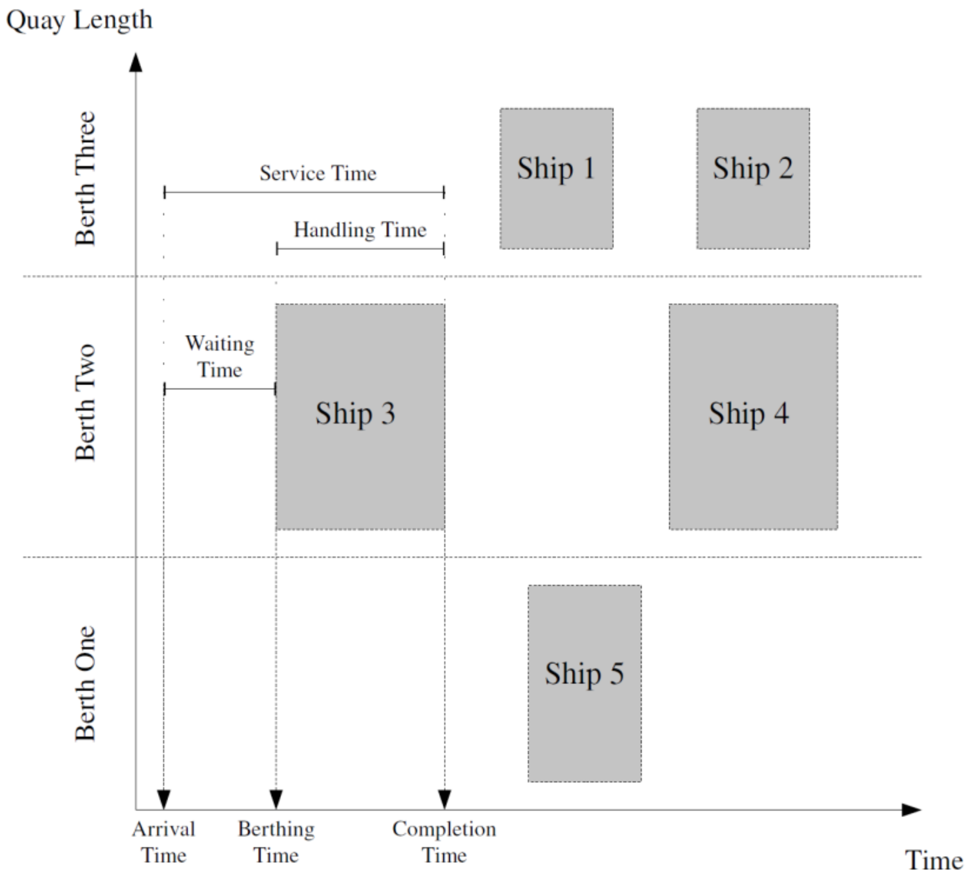

Fig. 1 The representation of the berth-time space

The handling time of a ship depends on its position at the quay. This reflects reality in that containers are prepared for particular ships, and the driving distances from the stowage area to the berth must be considered.

The BAP can be also modeled as a static problem (SBAP), if all vessels to be serviced are already in the port at the time the scheduling begins, or as a dynamic problem (DBAP), if some of the vessels have not yet arrived but their estimated time of arrival (ETA) is known in advance. Service priorities and "preferred" berth position for a certain vessel are two issues addressed in some of the BAP published work. Service priorities have been addressed by assigning weights to vessels. The second issue has been treated through penalizing berthing assignments by a factor proportional to the distance from a preferred point, relating to the distance of the berthing area from the storage yard area, where containers to be loaded on board the given vessel are stored (also known as the preferred berthing point). According to Cordeau et all (2005) though, planners prefer to handle this aspect by increasing the expected handling time according to the quay segment where the vessel moors. Finally, technical restrictions such as berthing draft, inter-vessel and end-berth clearance distance, that bring the problem formulation closer to real world conditions, are other issues that have been considered.

The problem of the SBAP and DBAP along with the discrete and continuous BAP has been widely studied in different combinations. Most of the studies, as will be seen in more detail in the next section, try to minimize the total service and waiting time (total completion time-TCT) and/or the deviation from the preferred berth, since it is expected that minimization of the deviation from the preferred berthing position will reduce service time and operator's cost. These objectives, however, do not take into account the issue of meeting contractual agreements for the vessels' scheduled start of cargo handling operations and/or departure (which can be denoted as the time of departure after the scheduled arrival in the port). Contractual arrangements can vary from berthing (and start of cargo handling operations) upon arrival, to guaranteed service time window and/or guaranteed service productivity (UNCTAD, 1986). Earliness or lateness of a vessel's handling operations completion time (loading/unloading of containers) implies benefits or costs to both the port operator and the ocean carrier. If these operations are completed after an agreed upon time, the port operator may pay a penalty to the ocean carrier, while if these operations are completed before that time, the carrier may pay a premium fee to the port operator, subject to the contractual arrangements, although in practice premium may be compensated with past or future penalties assigned to the port operator due to failure to meet the terms of the contract. Early departures can help ocean carriers in managing the time factor of their service schedules, by providing time buffer to cope with time lost in other ports (Notteboom, 2006). Early premiums can be offset by reducing voyage operating cost through reducing the voyage speed and therefore the fuel consumption. In fact, recently, ocean carriers seek to reduce operating cost through voyage speed reduction, while maintaining service reliability (Savvides, 2006 and Lloyds List, 2006).

To our knowledge, research deviating from the general formulations and considering a penalization approach has only been presented by Kim and Moon (2003), Park and Kim (2003), and lately by Wang and Lim (2006). Kim and Moon studied the continuous SBAP with the objective to minimize the cost from non-optimal berthing and the penalty from delaying the departure of a vessel. Their formulation considered handling times as independent of the berth assignment and benefits by early departures were not considered. Park and Kim (2003) minimized the weighted sum of the handling cost of containers, the penalty cost incurred by berthing earlier or later than the expected time of arrival, and the penalty cost incurred only by the delay of the departure beyond the promised due time. Wang and Lim (2006) also consider only the penalty costs from delayed departures.

In [6] considered the model of DBAP, builds on a well-known encoding scheme used for VLSI design and rectangle packing problems. Extensive simulation results based on a set of vessel arrival data shows the promise of this approach. For a moderate load scenario, this approach is able to allocate space to over 90 % of vessels upon arrival, with more than 80 % of them being assigned to the preferred berthing location. This achieves a significant increase in port efficiency: reducing waiting time of vessels, as well as during loading and unloading operations.

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SYNERGY AS PARADIGM OF THE STUDY OF PORT DEVELOPMENT

Based on the analysis of existing theory of the port development prediction and control was found the contrariety between existing models and requirements of practice. To study the strategic characteristics of ports development, especially included in the associated spatial-economic clusters, it is convenient to use well established in other fields of knowledge.

Keywords: *port, port-oriented logistics, synergy, hinterland*

A modern port complex is a high-speed, multi-level dynamic system. It is a set of interrelated elements of production, which are stably integrated, and therefore cannot be adequately displayed using a simple linear system without losing its basic properties. Therefore, is it appropriate to use methodology based on scientific synergy to study the properties of the object. This has already proved its effectiveness in many domains of knowledge [1, 7, 8].

At the heart of the synergy is the search for common patterns of development of any system over time. Abandoning the specific nature of the systems, the synergy gains the ability to describe their evolution in a universal language. It sets up a kind of identity, or isomorphism phenomena, which can be studied using various scientific methods, but with a common model, or to be more exact, moving towards a general model. Finding a unified model allows the synergy to be understood in different scientific fields.

The three basic concepts that characterize the studied systems are formed in synergy: disequilibrium, openness and non-linearity. Openness refers to the ability of the system to exchange material (energy and information) with the environment and to have a "source" – zones recharge their energy environment, and "sinks" – scattering areas, a "discharge" of energy.

Disequilibrium is the state of an open system, in which there is a change in its macroscopic parameters, such as its composition, structure, and behavior [2].

The non-linear system is called the property of having in its structure a variety of stationary states that correspond to different valid laws of behavior of the system. Whenever the behavior of these objects can be expressed in a system of equations, the equations are non-linear in a mathematical sense. Non-linearity is also seen as an unusual reaction to external stimuli, when the "correct" exposure has a greater impact on the evolution of the system than the impact of its own trends, if they are stronger but poorly organized [3, 9].

In this sense, an important achievement of synergy is the discovery of the mechanism of resonant excitation. This means that the system, in a non-equilibrium state, is extremely sensitive to the effects that agree with its own properties. Small but consistent external influences may be more effective than large influences that are less consistent.

Open non-linear systems may respond differently to the action of external forces and changing internal factors. In some cases, the system will respond by creating the strong trends and return to the old state (structure, behavior), in other cases the system may collapse. Finally, there is the possibility of the formation of a new structure, and a complete change of state, behavior, or the composition of the system. Any of the above features can be realized in the so-called bifurcation point. This is caused by the above effects, in which the system experiences instability.

The bifurcation point represents a watershed, a critical moment in the development of the system in which it selects its path. In other words, this is the point of the branching option, at which there is a disaster. In the concept of self-organization, the ideas of being qualitative and discontinuous can be referred to using the term "catastrophe".

Synergy adds a systematic approach to investigating the complex structures that are far from equilibrium. From cybernetics and systems analysis, the existence of some systems of collective interactive mechanisms is well known. As a collective, the systemic interaction of elements leads to the fact that certain components of the movement are suppressed. Thus, we should speak about the presence of negative feedbacks. Strictly speaking, it is negative feedback that creates a "traditional" system. This is understood as a stable, conservative, group of members. However, when the system moves away from equilibrium, the dominant role is played by the positive feedbacks that are not suppressed, but on the contrary - strengthen the individual movement of components. Small impacts become more significant, the more processes are located on the macro level. Positive feedback leads to the loss of stability of the system of the organization, as a very small deviation can have a big impact. Positive feedback loops make it possible for states far from equilibrium to add very weak deviations to the giant waves that destroy the current structure of the system and lead it towards revolutionary change – a sharp qualitative leap [4].

Mathematically, it can be assumed that any dynamic system, no matter what it represents, can change its settings to describe the motion of "representing" the point in space called the phase. The phase space provides a convenient way to visualize the behavior of dynamic systems. Changing the state system in time, such as with a succession of its states, can be represented by a line in the phase space - the space of possible states of the system, which is not time-dependent.

The phase trajectories (lines in phase space) allow one to see any entire set of movements that may arise under all possible initial conditions. The picture of the phase trajectory is important as an attractor, which characterizes the behavior of the system in the phase space after a certain (relatively long) time. In other words, it is a point or a subset of the phase space, which seeks all trajectories in the neighborhood of the attractor, also known as an area or a "swimming pool". The trajectories, going from their initial states, eventually approach the attractors [5, 6].

Attractors are a concept that refers to the active centers of potential sustainable ways of evolution of the system, and the ability to attract and organize the environment. The "Attractors" theory allows us to understand the essence of complex system management. Attractors divide the space of all possible states into various areas of attraction. Once inside, a system inevitably evolves into the corresponding attractor. This is caused by the threshold nature of any external influence on the system. The impact can be effective, and will change the system trends, only if it takes the state of the system in the domain of attraction of another attractor. The closer the system is to the asymptotic stage of development, to its attractor - the more difficult it is to “switch" it to another attractor. The threshold of the exposure plays a major role here. The former attractor does not let go of the system, and it is necessary to make substantial efforts to overcome the current trends, and get out of its field of attraction. Long-term, is too weak. Topologically incorrectly, directed action would only be a waste of time and energy, and the system will be back on track.

Barcelona port. Example of resonant fluctuation

This case of study shows that the hinterland strategy developed and implemented by the port authority of Barcelona provided more benefits than it were used standard strategy to invest money in developing port capacity and infrastructure. Moreover, this is an example of using the mechanism of resonant excitation, when slight, but well-coordinated with the internal state of the system external influence on it can be more effective than strong one but which is not coordinated with the system.

Port authorities generally focus on the development of the port area. As a result, port authorities (and governments) invest great sums of money in the development of port capacity and port infrastructure.

But only few of them consider becoming active outside the port area and investing money to develop supply chains in which ports are elements, in chains that add value for shippers

Here is a detailed case study of the hinterland strategy developed and implemented by the port authority of Barcelona (Autoridad Portuaria de Barcelona, APB in the remainder of the text).

Barcelona’s port is situated along the North East coast of Spain (Fig.1) The port of Barcelona mainly serves Catalonia: a region with 7.3 million inhabitants (16 % of the Spanish population) that generates 19 % of the GDP of Spain (Eurostat, 2011). Barcelona is well located to serve other parts of Spain. However, traditionally the port community and the port authority focused on Catalonia (Fig. 1).

Largest container ports around Barcelona and Barcelona’s main hinterland. This resulted in limited volumes moved to and from outside Catalonia.

Until 1998 APB acted as a traditional landlord port. In 1998 APB developed a strategy to actively develop hinterland by creating a network of inland rail nodes in several economic centers in Spain and France, and is still implementing this strategy. In Zaragoza, a central node was established in the hinterland network of Barcelona due to its location in between the economic centers of Barcelona, Madrid, Bilbao and Valencia. Therefore, Zaragoza has become a logistics hub and houses multiple distribution parks. The rail terminal in Zaragoza has also become a hub for trains going to Madrid, and additional services have developed from Zaragoza to the northern destinations of Burgos and Vitoria. Furthermore, Zaragoza also serves as a hub for repositioning empty containers from Madrid. Additional, expansion plans for the terminal are being implemented, as Barcelona almost doubled its traffic with Zaragoza within two years. The role of APB terminal in Zaragoza was of strategic importance for the future development of the network in Spain [10].

Fig. 1 Largest container ports around Barcelona and Barcelona's main hinterland

The hinterland's activities have resulted in a modal shift from road to rail (Table 1). Despite the decrease in container volumes rail transport increased between 2007 and 2009 (in 2009, volumes in almost all major European ports dropped significantly due to the financial and economic crisis).

Table 1 – Container traffic for Barcelona port in TEU (APB, 2007, 2008, 2009).

	2007	2008	2009
Total container volume	2,610,099	2,569,477	1,800,213
Transhipment volume	988,972	959,225	606,235
Volume, transhipment exluded	1,621,127	1,610,252	1,193,978
Total rail transport	41,770	52,562	59,544
% rail transport of total hinterland volume	2.6	3.3	5.0
% annual growth of rail transport		25.8	13.3

Obviously, the rail terminal in Zaragoza has had a major impact on these figures. It shows the competitiveness of rail transport in comparison with road transport. The transition from road to rail makes the port more accessible by decreasing road congestion, increasing the competiveness of the port and helping the port to grow.

This case under study shows that the hinterland strategy developed and implemented by the port authority of Barcelona provided more benefits than a standard strategy to invest money in developing port capacity and infrastructure. Moreover, this is an example of using the mechanism of resonant excitation, when a slight influence, but one which is well coordinated with the internal state of the system, can be more effective than strong one which is not coordinated with the system.

St. Petersburg port. Points of bifurcation

An example of such bifurcation points can be seen in two points in the history of the port of St. Petersburg:

A) The resolution of 1721 of the Senate of the Russian Empire on the concentration of export cargo in the port of St. Petersburg, which meant that St. Petersburg was the major port of the Russian Empire for the next century.

Table 2 – Vessels call to both ports in 1716–1719

Years	Arkhangelsk	St. Petersburg
1716	208	33
1717	146	51
1718	116	54
1719	119	33

The founding and development of the St. Petersburg port happened in fierce competition with the principal Russian port of the time, Arkhangelsk. Trade in the years from 1716–1719 is shown in table 2.

At the end of the Great Northern War, Peter I instructed the Senate to issue a decree on the concentration of export products in St. Petersburg. As a result, the previously intensive commercial activity of the Arkhangelsk City Exchange collapsed, as noted in Table 3.

Table 3 – Vessels call to both ports in 1722–1725

Years	Arkhangelsk	St. Petersburg
1722	60	119
1724	22	240
1725	19	236

B) The historic decision to build a Sea Canal in the middle of the 19th century in the port of St. Petersburg, which ensured that it became the leader among Baltic Russian ports up to 1917 and beyond.

By the mid-19th century, with the increase in the number of ships calling at St. Petersburg's port, it had become virtually impossible to handle vessels on the Spit of Vasilyevsky Island, and even more difficult to carry out loading and unloading operations in relatively small areas. With the increasing size of ships, the progress of vessels to spit became quite difficult. This was compounded by the construction of a bridge in the lower reaches of the Neva. In most cases vessels could not proceed through the stretches of the Neva known as the Nevsky bar. Therefore, the creation of additional transhipment platforms in Kronstadt was required. Vessels with significant draft berths came to

Kronstadt, where the goods were loaded onto barges, and transported to St. Petersburg. The depth on the Nevsky bar does not exceed three meters, and at low water can be as little as 2.5 meters. Of 2,600 ships annually arriving at Kronstadt in the middle of the 19th century, no more than half could traverse the Nevsky bar. The other half, carrying more than two thirds of the total cargo, were forced to stop in Kronstadt due to their size, and offload goods onto barges. This system of the delivery of goods led to additional costs because of double loading, damage, and loss of goods (for example, in the case of loading and transportation of coal in this way, 4 % to 8 % of the total was lost).

During the second half of the 19th century, the port of St. Petersburg had some serious competitors. To illustrate the competitive situation, statistics for the decade from 1865–1874 are shown, and they are quite revealing. During these years, traffic through St. Petersburg fell. Outgoing goods (exports) from Russia to Europe through St Petersburg fell from 28 % to 20.9 %, and imports (import) – from 43.6 % to 27.7 % (Fig. 2).

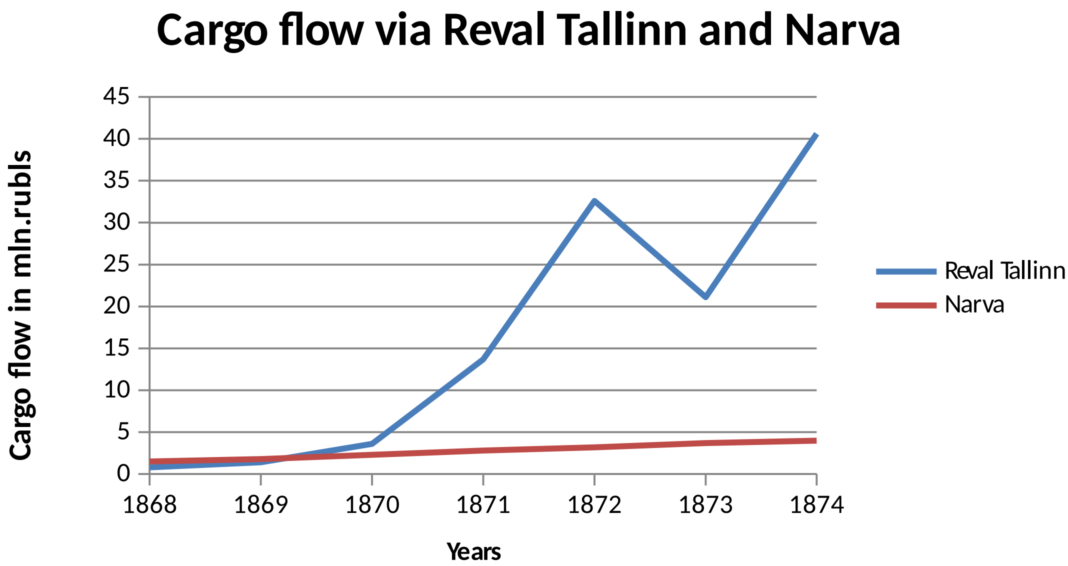

Fig. 2 Export and import statistics via St. Petersburg port

In order to avoid unnecessary congestion, goods started being discharged in Reval (Tallinn) and Narva, and then on the Baltic railway heading deep into Russia. For example, if prior to 1868 in Revel, goods were unloaded to the value of 600,000 to 800,000 rubles, then from 1869, the amount exceeded one million rubles and more. The dynamic was as follows: 1869 – 1.4 m; 1870 – 3.6 m; 1871 – 13.7 m; 1872 – 32.6 m; 1873 – 21.1 m; 1874 – 40.6 m. A similar pattern was observed in the port of Narva, where cargo turnover for the same period increased from 1.5 to 4 million rubles (Figure 3). Therefore, there was a choice between the three ports of St. Petersburg, Revel and Narva [11].

After a decision was made in favour of the Port of St. Petersburg, dredging work began, and a marine canal was completed from the island of Kotlin to the mouth of the Neva River in 1885. At the mouth of the Neva, major dredging works were also carried out, which led to the construction of three harbours. A small pool at the start of the fork of the channel levees ("Sea Pier"), and customs at the entrance of the harbour channel from the Neva ("Gutuevsky Port") were created in 1885. The third harbour, servicing the shipment of timber products and crops from abroad, was constructed during the period from 1897 to 1907, and was named “Wheat-Forest” (Fig. 4) [12]. Thus, the port of St. Petersburg became the leading Russian port on the Baltic Sea. A small pool at the start of the fork of the channel levees (“Sea Pier”), and customs at the entrance of the harbour channel from the Neva (“Gutuevsky Port”) were created in 1885. The third harbor, servicing the shipment of timber products and crops from abroad, was constructed during the period from 1897 to 1907, and was named "Wheat-Forest" (Fig. 4) [12]. Thus, the port of St. Petersburg became the leading Russian port on the Baltic Sea.

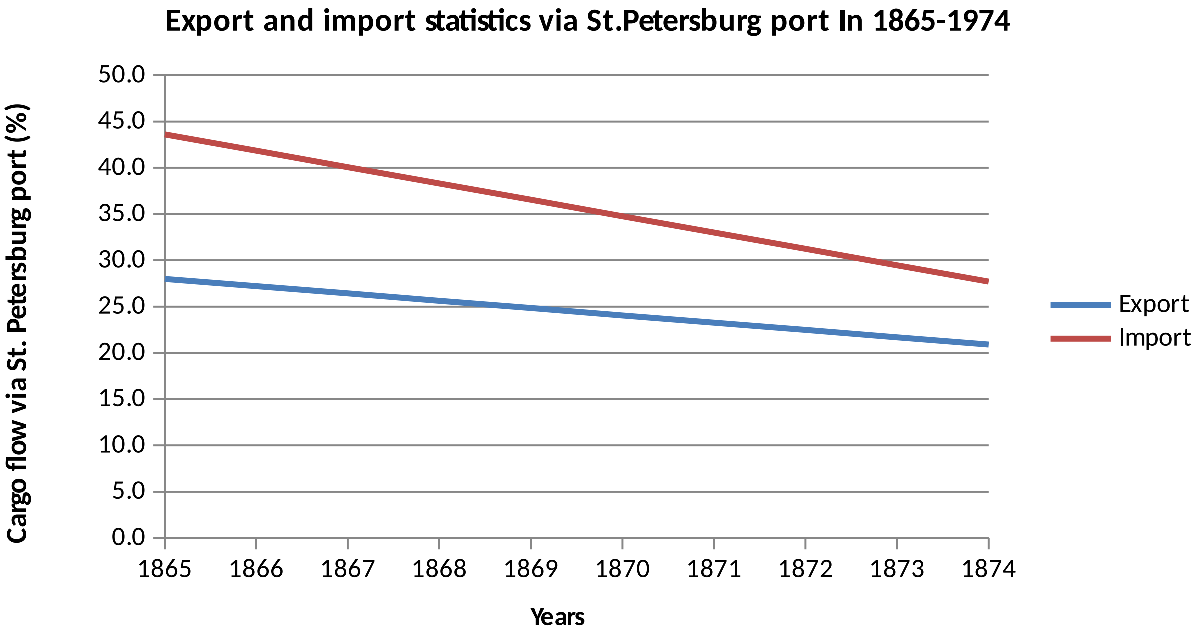

Fig. 3

Cargo flow via Reval Tallinn and Narva

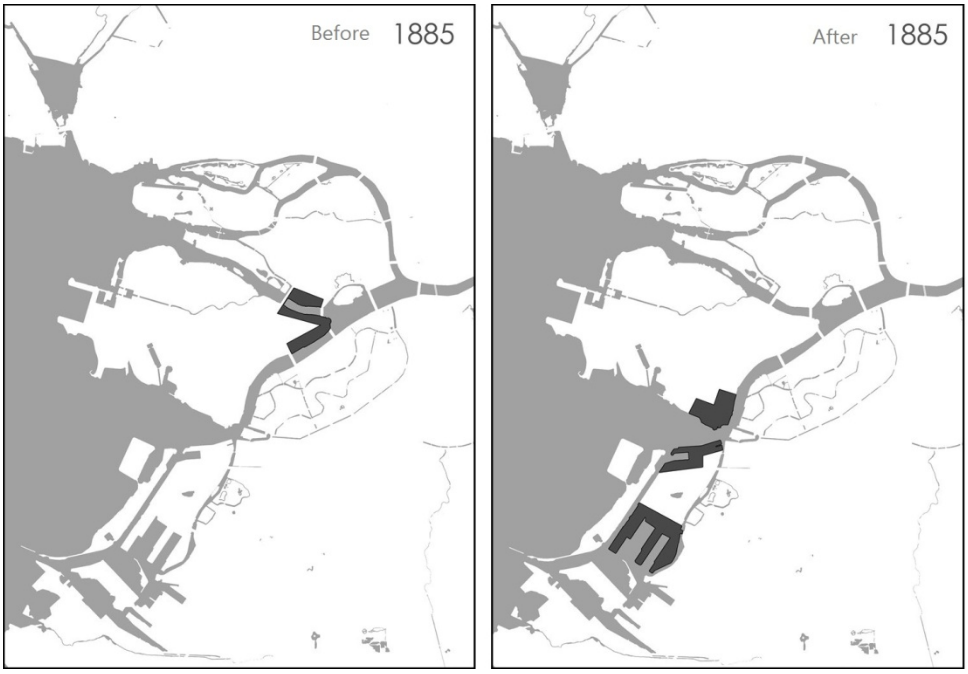

Fig. 4 Schemes of St. Petersburg port

Conclusions

Within the modern science of transport management, it is important to form a clear picture of its synergetic relationship with the world. The essence of synergetic control is the ability of complex nonlinear systems to "build themselves". All that is needed is the correct initiation of the desirable social trends in this system of self-development.

Based on the idea of the existence of synergistic "field development paths, the spectrum of structures, potentially contained, hidden in nonlinear media", and the role of humans in the world, we can say the following.

• Since every type of diverse development can grow following its own path, there is always the chance to not only select the best way, but also to manage it.

• While there are a large number of paths, this number is not infinite, and one can always try to establish specific system limitations - the exclusion principle, narrowing the space when searching for possible paths.

• There is a possibility in principle to describe and calculate the optimal and realistic terms of available capacity, as well as the proposed mechanisms for their implementation.

• Knowing the desired future situation and ways to follow the natural tendencies of self-organizing systems, one can reduce time spent on the attractor, or the future form of the organization.

Following the concepts of synergy in particular ports, or in the transport and logistics environment in general, it should be regarded as a super self-organizing, open, non-linear system, with all the associated properties, laws and principles of development.

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MODELLING OF VESSEL TRAFFIC DISTRIBUTION BETWEEN BERTHS IN A SEA PORT

A berth nomination for a vessel calling at a sea port is one of the most important decisions made on vessels arrival. It influences many aspects of port operations and performance indicators and first of all time of vessel's handling at the port. To perform forecasting and evaluation of different scenarios an effective instrument is necessary. This paper considers designing such instrument by means of simulation modeling. The designed model is proved to be adequate by means of queuering theory. Concerns of correlation between vessel distribution mechanism, cargo turnover and port performance indicators are discussed.

***Keywords**: simulation modeling, queues modeling, prototyping, adequacy proof.*

Introduction

Simulation modeling appears to be one of the most effective ways of evaluating performance of complicated systems. The issue of simulation modeling in transport logistics has been risen repeatedly [1], [2], [3]. This study describes functional extension of the existing methods. The simulated system is implemented by means of AnyLogic 6, as it is considered to be a convenient development environment for multipurpose simulation modeling.

Model description

Sea port is a complex system, which involves multiple concerned parties simultaneously. A company may have varying contractual obligations for different partners. If a sea port is considered as a queuering system, such variety consists in entity prioritizing, which means that some clients (shipping lines) may have higher priority for a berth operator, than the others.

Logically the model is represented by a chain of interconnected structural elements. These elements transfer entities, entering the system. Each entity represents a vessel call at the port. Having entered the port, the vessel is put into anchorage queue. Anchorage queue is simulated virtually, as a sum of sub-queues at each berth. This means that vessels are considered disposed at anchorage, but each vessel has the information on its berth of handling already.

It is important to nominate handling berths for vessels rationally, as it influences both shipping line and berth operator expenses. Time, that vessel spends in port, seems to be appropriate criterion for such rationalization. The lower the time of port operations for a vessel, the lower are the expenses of a shipping line for calling at this port. At the same time, lower time of port operations for a vessel allows berth operators at port to handle more vessels, providing them greater profit. Basing on the above the following vessel distribution mechanism was implied: when a vessel enters the port, each berth is assigned with a value of inexpediency. The inexpediency is calculated as a sum of time of handling left for a vessel under handling at this berth and expected time of handling of each vessel in a sub-queue at this berth. The lower the inexpediency, the more rational it is to nominate this berth for a calling vessel. The inexpediencies of berths are compared afterwards. Only berths that can be entered by the given shipping line are considered when comparing inexpediencies. The berth with the lowest value of inexpediency is selected and the calling vessel is put into corresponding sub-queue. If a vessel cannot enter any of the berths in principle, it is refused to be handled and instructed to leave the port.

Logical implementation of the described mechanism is represented on Fig. 1. The calculation of berth inexpediency is performed inside vessel traffic distributor element. It receives each vessel's properties as inputs and provides the number of its out port. Each distributor's out port leads to corresponding berth or to the sea port's exit.

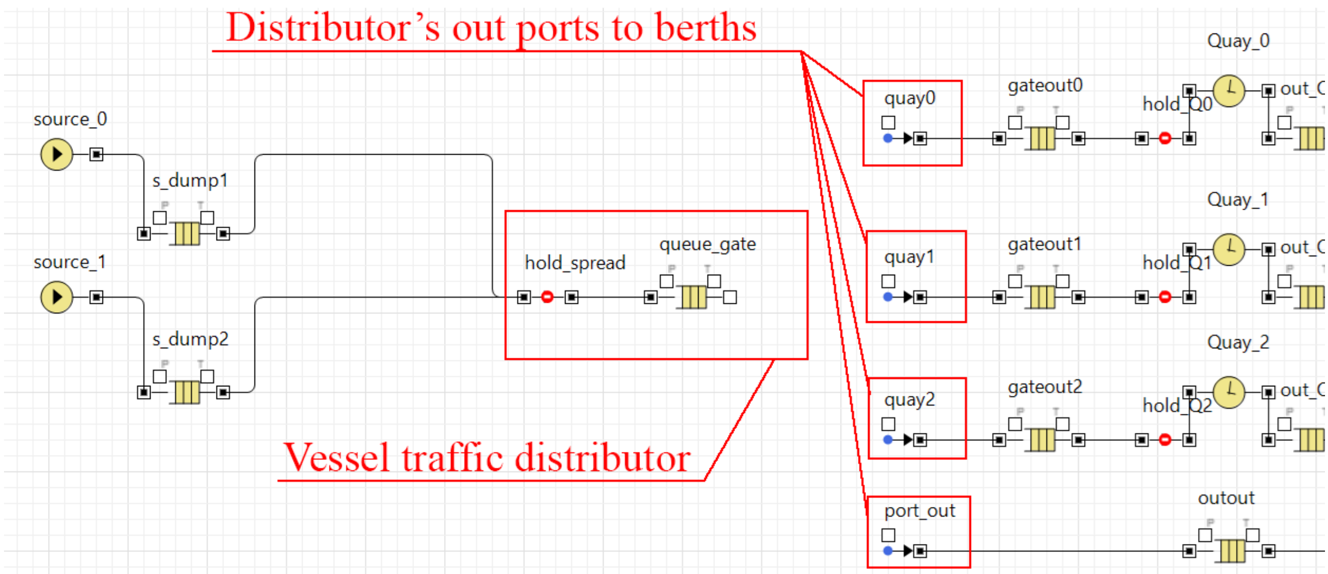

Fig. 1 Model's logical structure

As it was mentioned vessels can enter only those berths that they are allowed to enter in principle. This is regulated by means of stevedoring agreement matrix, which determines which berth operators have agreements with which shipping lines. It is a common practice though, for a berth operator to have a prioritized client among carriers. In this case the inexpediency of nominating a berth to the prioritized client for this berth operator should be lower. To imply this mechanism a matrix of prioritization is implemented. The higher the level of priority for a certain shipping line at current berth, the lower the resulting inexpediency of this berth for vessels of this shipping line.

The model's input variables are: sea port's annual cargo turnover, shipping line's share in turnover, vessel's call size, number of STS cranes demanded by a vessel, number of STS cranes available on a berth, STS crane productivity. Model outputs data on vessel traffic for each berth, relative waiting time for each shipping line's vessels at each berth, sub-queues lengths and structure

Experiment planning and results

A number of options were considered while planning the experiments on the model:

1. Shipping lines have the same level of priority on all berths, all shipping lines' vessels have equal properties, all berths have equal properties;
2. Shipping lines have the same level of priority on all berths, shipping lines' vessels have different properties, berths have different properties;
3. Shipping lines have different level of priority on all berths, shipping lines' vessels have different properties, berths have different properties;

The first series of experiments was performed mainly to test the adequacy of the model. It is apparent, that if properties of all vessels and all berths equal, then model narrows down to the classic multi-channel queuing model. This allows to test the results of the simulation by means of the queuing theory. The test proved model's adequacy.

During the second series of experiment all shipping lines had equal levels of priority at all berths. However, vessels' properties were different for different shipping lines, as well as berth's properties were different for each one. In conditions of low levels of cargo turnover this lead to the fact that vessels with higher demand in handling equipment were more likely to have a nominated berth with higher supply of STS cranes. In conditions of higher annual turnover vessels could not be distributed like this due to the lack of port resources. This lead to gradual vessel traffic equation at all berths.

The same is true for the third series of experiments, where all the vessels and berths have different properties and levels of priorities are different for each shipping line. The results show, that in conditions of low cargo turnover vessels had tendency to gravitate towards berths operated by prioritized companies. On the other hand, when the cargo turnover is high, vessels start to distribute in a more uniform way between the berths.

Example of results of an experiment performed on the model is represented on Fig. 2.

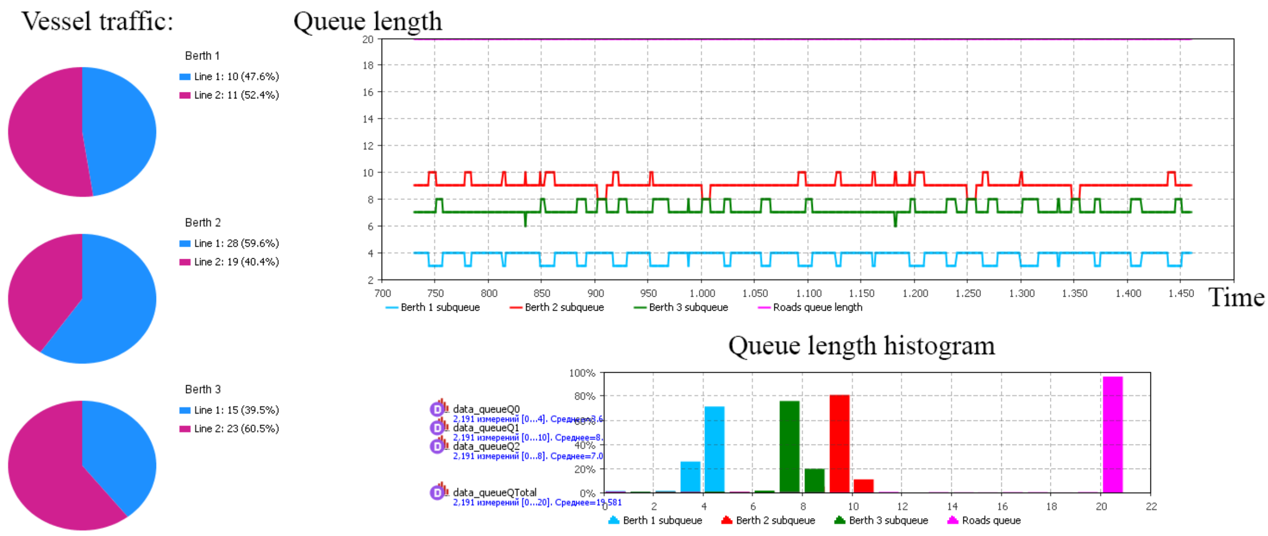

Fig. 2 Example of experiment results

Conclusions

1. Model of a vessel traffic distribution between berths is described. The model allows to evaluate some port performance indicators in different scenarios of inputs.

2. Correlation between the cargo turnover, vessels' and berth properties, priority levels and some port performance indicators is revealed.

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