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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" (6–7 April 2017), 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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CONTENT

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ANALYSIS OF EXISTING MODELS OF PORT DEVELOPMENT

The models for ports and terminals development are treated, as well as main driving forces and constraints affecting these processes. Major factors are identified and their individual and joint impact on the port view as a holistic system. The reasons of interest to the ports models development are explained. Five main port development models are included in this paper. It is stressed that every model of this set served as a source for various modifications and variants, enhancing the prototypes in a certain aspect. Presented models are studied over historical background that enables to identify important stages in the development of the scientific approach to the problem of port model development. The factors and forces considered in each model are studied, as well as their influence on port development trajectory. The key benefits of each model was Identified, detailed analysis is made of the disadvantages. The reason for the lack of a universal model is formulated. Objectives of further research are outlined.
Keywords: port, terminal, regionalization, logistics.

Fundamental changes in the world economy and transport infrastructure have occurred over the past decade and seaports have been as affected by this as any other aspect. Today, these key infrastructure elements are in need of solutions that take into account the challenges of the modern world: competition, environmental pressures, lack of space, lack of capacity, and the requirements of logistics and supply chain management. Success or failure in dealing with these issues depends on how well the port sets its development goals, as well as how to achieve those goals. The initial capital required for the construction of the port infrastructure, and the fact that once something has been done it is very difficult to reverse, leads to high rates of error in determining the course of development.

The theory and practice of forecasting and managing the development of ports has been actively studied since the middle of the last century. The result has been the creation of a number of models describing the steps of development that are influenced by a number of port-specific forces. According to the researchers, these steps determine the development of ports. The English scientist James Bird proposed the first model of a port in 1963, which described how port infrastructure develops, both spatially and over time [1]. In his concept, Bird describes the six stages of development of a port:

- *Setting of the port*: this step includes the initial forming of a port, marked by small and shallow piers, adjacent to the city centre;
- *Marginal quay extension*: achieving the possible expansion of the boundaries of the port in the city centre, without building new cargo berths;

- *Quay elaboration*: the port has reached a stage where the technical possibilities for processing vessels in the initial berths have reached a maximum. This is associated with the development of cargo handling equipment and the size of the vessels;

- *Dock elaboration*: this stage of expansion of the port, and the creation of new, deeper and extended berths, capable of taking larger ships, and in greater numbers, is in most cases associated with a move along to coast towards the mouth of the river.

- *Simple lineal quayage*: this stage is typified by the modernization of cargo handling equipment, in order to speed up the processing of large vessels and tonnage;

- *Specialized quayage*: this stage is typified by the orientation of the quays and port handling equipment towards the processing of specific types of vessel and cargo.

The author notes two main strategies of port development:

- *spatial development*, which can be recognised as a movement away from the city centre, by creating new deep-water multi-purpose berths in available space. At the same time there is a gradual change in the usage of the original port areas of the city. These areas are usually located close to the city centre, and are often converted into parks, housing, and commercial developments;

- *specialized handling equipment*, or the creation of cargo handling facilities or ports, which enable faster processing of specialized ships, and reduce cargo handling costs.

Bird noted that port development is gradual. Different parts of the port may be at different levels of development at any one time. This means that sub-optimal equipment may be in use in some parts of the port, while others are using units that are more modern.

Although initially Bird's model was shown to be effective, it has displayed a lack of flexibility. Attempts have been made to resolve this, by introducing several phases: *closure, expansion, addition, consolidation*, and *conversion*. On the one hand these "fixes" allow us to better explain the process of development of a specific port, but on the other hand can lead to the loss of universality of the model. Some authors believe that the six steps can be grouped into three main phases: setting, *expansion* and *specialization*. The first such proposal was made by the, Jean-Paul Rodrige and T. Notteboom [2] (Figure 1).

At the same time, Bird emphasized that he developed his model based on the stages of development of certain ports, and it was not designed to meet the criteria of all ports. He acknowledged that a model of port development could be based on various factors. Although his model is called "Anyport", it is based on the development of port facilities to meet the growing needs of the navy, and does not take into account factors such as the relationship of the port with the city, the availability of hinterland and its development, and the specialization of ports.

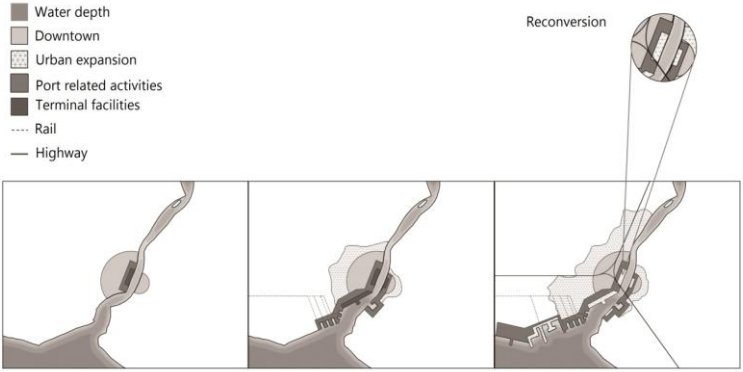

Fig. 1 – The three stages of development of a port, according to James Bird and J.-P. Rodrige., T. Notteboom

The United Nations Conference on Trade and Development (UNCTAD) in 1985 presented its own concept of port development, summarizing the results obtained by Bird and his fellows, and focusing on the cargo-handling aspects of the port's operations. This concept was based on the fact that the driving force behind the development of ports is an increasing volume of cargo flows and changes in the structure (Fig. 2). In accordance with this concept, a suggestion was made to divide the development of ports into five stages [3].

Traditional. At this stage of development, the port is just a group of general-purpose berths, which are capable of handling general cargo – for example piece and bulk cargoes in packaged form, such as wheat in bags, oil drums, and fertilizers in bags, or cargo with packing in the hold.

Bulking of dry cargo. Upon reaching certain cargo size levels, it becomes economically feasible to transport a bulk cargo load on specialized ships, known as bulkers. Some of the total volume of the cargo is defined as a special new type of cargo flow - bulk cargo, for which the port has to provide a separate berth with specialized lifting and handling equipment. Therefore, the appearance of bulk cargo terminals is a natural requirement. At the same time, equipment for handling general cargo is modernised, and mooring lines are expanded, as a result of the constant growth in traffic, and of the size of vessels.

Advent of unit loads on conventional ships. This stage is characterized by two major trends. The first of these is the appearance of a means of integrating packaged unit loads: pallets, big bags, boxes, crates, containers, packages (metal rods, pipes and so on.). Firstly, these make up a small proportion of cargo traffic. Handling this type of cargo takes place on general cargo and shipping quays, using conventional vessels. The second trend is a steady decrease in the volume of general cargo due to its reallocation as bulk cargo. At the same, time the volume of bulk cargo is considered to have reached a significant level when different terminals are required for different types of bulk cargo.

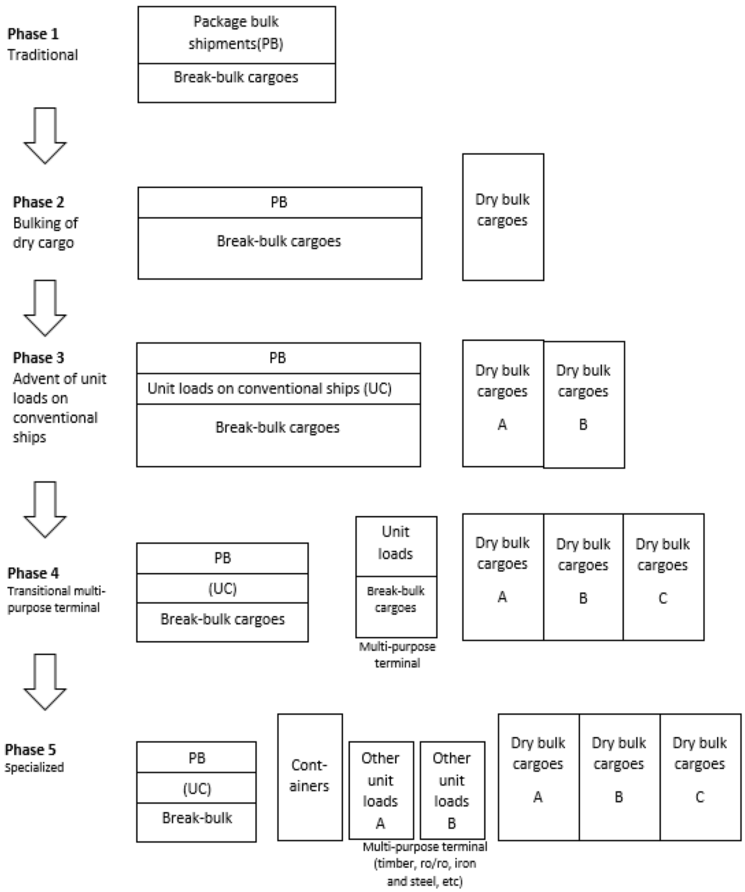

Fig. 2 – Steps for port development in accordance with the UNCTAD concept

Transitional multi-purpose terminals. The increased usage of cconsolidated cargo units (CCU) and the emergence of specialized vessels for their transportation (timber trucks, car carriers, ro-ro ships, container ships and other cellular types of container) all require special handling equipment. At the same time, the cargo flow of each type of CCU is small, and the prioritization of CCU cargo traffic in the future is unclear, due to which the need arises for a flexible multi-purpose terminal, which replaces the older general cargo berths.

This type of terminal can easily be converted into a specialized terminal for cargo, as long as it is of a sufficiently high level to be able to cope with different types of cargo. This will be a priority in the near future. Additionally, this stage will see a continuation in the growth and diversification of the flow of dry bulk cargoes.

Specialization. The final stage in the development of any kind of traffic it is to reach such a volume, that it is necessary to use a specialised fleet for its sea transport, and specialised terminals to handle it in the port. In this case, multi-purpose terminals can be easily converted into terminals, which are specialised for the processing of cargo through. This can be achieved through the purchase of additional equipment, and slight modifications of existing equipment. By the time the fifth stage is reached, the residual volume of general cargo is significantly less than it used to be, and the processing of the main cargo types (timber, iron, steel) is grouped in the multi-purpose terminals.

This model explains the historical reasons behind the changing nature of sea traffic and port development strategies. However, it has limited applicability in the present context of prevailing factors which influence cargo traffic. The model is based on just one factor, albeit one which heavily influences the development of the port with regards to the long term potential for economic change. The influence of other relevant factors is ignored.

The increase in commercial factors, efforts to expand the port area, and the emergence of the concept of the port as a “service centre", all mean that a new understanding was required, of how to develop ports, and why this was needed. By the end of the twentieth century, UNCTAD, drawing attention to the radical changes taking place in the role of ports in the world, introduced a new stage for the model of development studies. As a result, the conceptual model, which includes three generic phases, or "generations" of port development (Table 1) was proposed.

Table 1 – Development model for the UNCTAD port

Period of development	**First generation**	**Second generation**	**Third generation**
	Before 1960s	**After 1960s**	**After 1980s**
Main cargo	Break bulk cargo	Break bulk and dry liquid bulk cargo	Bulk and unitized containerized cargo
Attitude and strategy of port development	Conservative Changing point of transport node	Expansionist Transport, industrial and commercial centre	Commercially oriented Integrated transport centre logistic platform for international trade
Scope of activities	1—Cargo loading. discharging, storage, navigational service Quay and waterfront area	1 + 1—Cargo transformation, ship-related industrial and commercial services • Enlarged port area	1+2+ 3—Cargo and information distribution; logistics activities Terminals and distribute towards landside
Organizations characteristics	Independent activities within port Informal relationship	Closer relationship between port and port users Loose relationship between activities in port	United port community Integration of port with trade and transport chain Close relationship between

	between port and port users	Casual relationship between port and municipality	port and municipality Enlarged port organization
Production characteristics	Cargo flow Simple individual service Low value added	Cargo flow Cargo transformation Combined services Improved value added	Cargo information flow Cargo information distribution Multiple-service package High value added
Decisive factors	Labor capital	Capital	Technology know-how

The principles of the division are based on a set of key factors: port development policy; strategy; scope and limits of the expansion of the port area; the degree of integration of port functions and organizational structure of the port. At the same time, the concept also discarded a number of important factors, such as the scale of the port, its geopolitical situation, and the ratio of public to private ownership. The development has been studied in a modular fashion, and the transition from one generation to another was associated with the growth of the port, and is partly determined by the motivation of decision-makers [4].

First port generation in this model play the role of an interface between sea and land transportation. They were not designed for any transportation or trading activities, and therefore were far from meeting customers' requirements. The same detachment and lack of interaction can be observed between the port and local authorities of the city in which the port is located. They were independent from each other, and never considered cooperating in order to promote the port on a commercial level.

Second port generation already differ, in that they offer several advanced functions, which mean they can be considered to be a "centre of transport, industrial and commercial services." All these new features can be described as "commercial activities, adding cost to the cargo handling operations." The port becomes more open to cooperation with the transport industry and freight principals, as well as for cooperation with the relevant local authorities. Second generation are no longer geographically isolated from the rest of the transport industry.

Third port generation is the product of a world of globalization and integration. They are treated as dynamic components of the international production and distribution systems, forcing the owners to adopt a pro-active approach. This turns ports into integrated transport centers and logistical platforms for international trade. The functions of such ports are more specialized, diverse and integrated, still including all the features of first and second generation ports. At this point, the importance of using modern port equipment and advanced information technology starts to become very clear.

Industrial services in this model are divided into two categories - vessel-oriented, and cargo-oriented. In order to aid the development of the latter, industrial zones were created, the purpose of which was to attract traffic. At the same time, development began of environmental measures, which were aimed at reducing the harmful effects of port operations.

The third generation of ports dramatically increased administrative efficiency, by way of improving the processing of documentation, and with the appearance of the modern information technologies. The quality of day shift planning has also improved, ensuring the best use of port infrastructure. Administrative and enhanced commercial services of third generation ports reached a new level of quality.

The port's operations incorporated into its capabilities both goods distribution and logistics systems. This freed the ports from their traditional functions of medium and long-term storage of goods. Containerization has also transformed the port into a "checkpoint corridor", where the goods are no longer delayed, thus reducing the chances of incurring additional costs.

The model described is a useful tool for analysis and comparison, which has made it a popular and well-recognized tool for several decades. At the same time, the simple "black and white" analysis, inherent in this model of development, quickly made it less realistic and accurate, as non-representative events influenced the rapidly developing world port industry. Practitioners noted that the development of ports did not always follow the distinct stages, and not all ports followed the same cycles for the transition to the third generation. Moreover, some port terminals displayed a different line of development, as they responded to specific requests. Commercial pressures and goals were the main determinant of this development, and the introduction of new equipment and technology is a continuous process. As a result, even the most advanced ports in terms of systems, equipment or terminal port projects often retained aspects of the earliest stages of development, which contribute to overall efficiency.

In addition, shipbuilding and shipping organization have showed changes that were not predicted during the creation of the models of the 1980's. Considerable complexity of the objective classification of a port of any particular generation has arisen: this procedure has always been quite subjective, and therefore carries a risk of error, since every port, to a greater or lesser extent, is unique.

Most of the important processes described in terms of successive generations of the UNCTAD port model, were ambiguous and imprecise. Development is not fixed at any one time, and does not necessarily pass through the development cycle to obtain third generation of port status. Therefore, the model selection of distinct "port generations" may not accurately reflect the port industry on a global scale. With careful study, it becomes clear that this model does not reflect the situation that dominated over the past four decades. A wide range of other factors, such as port size, geographical location, work culture, and the degree of public / private involvement, have all showed significant changes. All this must be taken into account, in order to better describe the current situation in the ports, which could not realistically be divided into categories of "generations."

Fundamental problems with the model of "port generations" mean that models can no longer include all the changes that have occurred in the port business over four decades. Characteristics of ports should not generalize by way of their fixation on a particular chronological stage. The model should reflect changes over time and at the same time should consider the importance of categories for individual aspects. In this sense, it is necessary to include a much wider range of properties and characteristics than those that were predicted in early models. The importance of aspects such as the culture of doing business in a port, labour and environmental protection, social issues and others began increasing.

All of this led to the emergence of a new port development concept model, which was given the name WORKPORT [6]. The main features of this model are shown in Fig. 3.

Table 2. WORKPORT schematicmodelof the transition processin Europeanports.

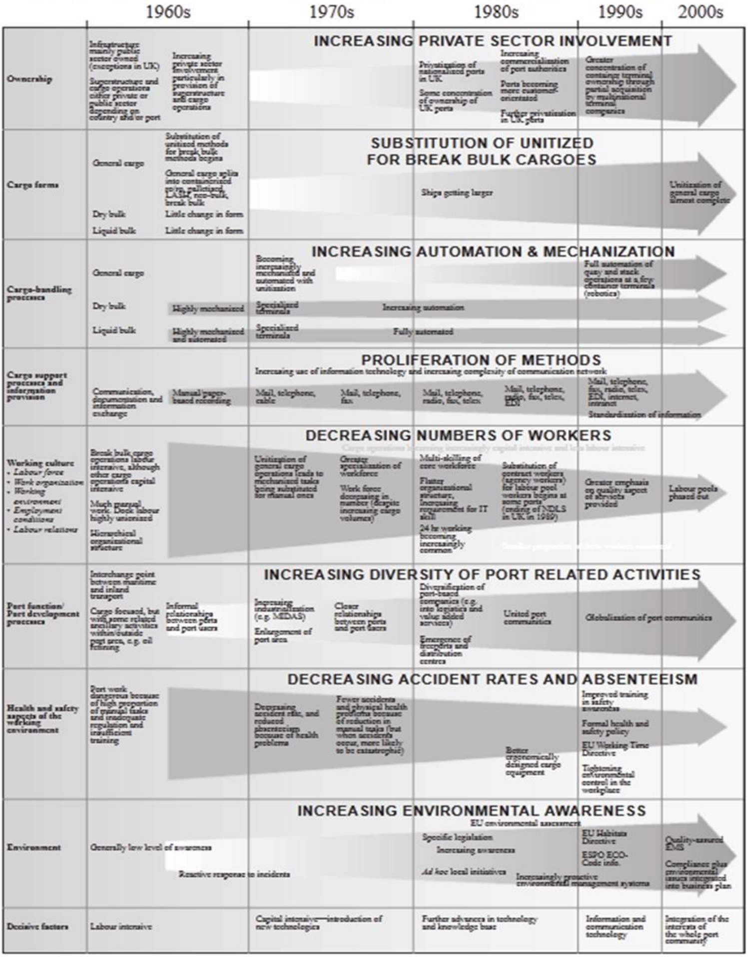

Fig. 3 – Schematic model of the processes in ports, according to the WORKPORT model

In this figure, arrows show the main trends observed in the development of ports, which are the key to finding ways to improve efficiency and growth opportunities for both the port authorities, and companies operating in the port. Eight factors that characterize the development of the port have been chosen, plus a factor that characterizes the main difference between each development period. The eight factors are: ownership, cargo forms, cargo handling processes, cargo support processes and information technology, working culture, port functions and port development process, health and safety, and environmental protection.

In the 1960's, ports were mostly a point for load division between sea and land transport. Because of this, they were focused on cargo, but only concerning the aspect relating to the movement of goods from one mode of transport to another. In the 1970's, port functions and processes gradually developed in conjunction with the free trade zones which were emerging around the same time, and within the context of closer and more comprehensive relations that began to take shape between the ports and port users. In the 1980's, parts of the port diversified within the developing field of logistics and began offering services which added value. The transport chain is integrated to varying degrees, depending on the particular load, and customer requirements. The 1990's showed the development of the globalization process in the port industry in the form of mergers, acquisitions and joint operations, which were becoming increasingly common and complex. The authors emphasize in the model that all the changes that occurred in the development of the port functions, were evolutionary rather than revolutionary way, as shown in the "generations port" model.

The WORKPORT model greatly expanded the range involved in the analysis of the factors and characteristics that were taken into consideration, adding new connections and patterns, and thereby serving as an important step in the development of theoretical concepts. At the same time, it is a bias towards a meaningful description and statement of events, making it difficult to use it as a tool for forecasting and analysis of the generalized type. In addition, this model does not fully reflect the role of the advanced development logistics, and the influx of new processes.

As a response to the emerging social needs in the area of the port and the transport and logistics business in the late twentieth century, J-P. Rodirge and T. E. Nottebum proposed several models which develop these ideas [2]. They combined different approaches, taking into account aspects of urban development. The authors added the factor of "port regionalization" to Bird's models. This allowed them to explain the reasons for the emergence and development of transshipment ports, the formation of logistics poles, and other aspects of the integration of ports in the hinterland (Fig. 4).

The revised model of development of the port system was based on two main provisos. The *first point* combines offshore hub ports with an insular location (and continental ports with limited hinterland) into a single system of container distribution, which forms a hinterland of other continental ports, to which they are connected by feeder lines.

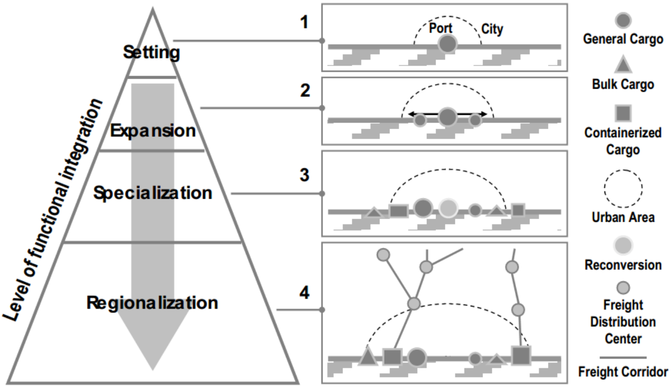

Fig. 4 – Port Development Model J.-P. Rodrige and T. E. Nottebum

The *second point* relates to the inclusion of inland freight terminals as active centers in the formation and development of port hinterland. The port regionalization phase is added to Bird's model as the next stage of development, marked by a strong functional relationship (and even joint development) between ports and multimodal and rear logistics platforms. This leads to the formation of a regional network of commercial centers, and to the expansion of port hinterland (Fig. 5).

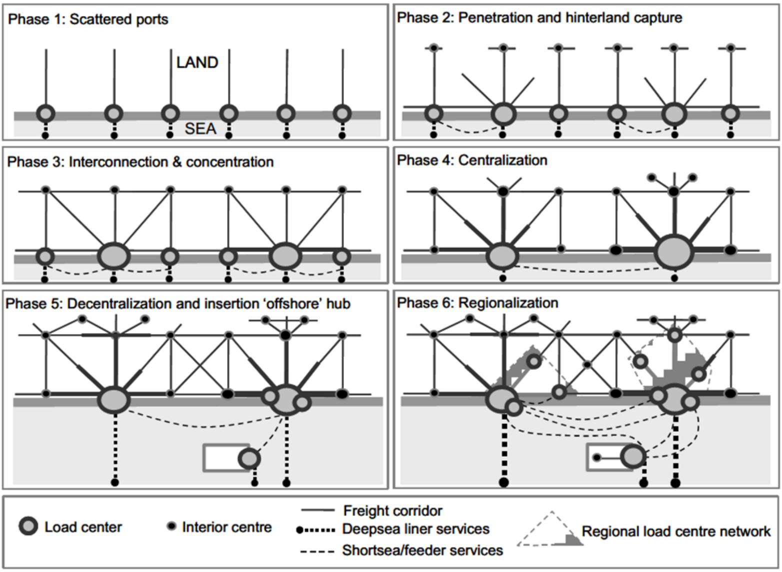

Fig. 5 – Development of the Rodrige – Nottebum model

The key difference in the model of port regionalization lies in the fact that it explores the development of ports in terms of dynamics, considering hubs, rear logistics platforms and ports as a single system, forming a goods distribution network. The authors of the model indicated that during the transition to this phase, there is a gradual regionalization and market-driven process which influences the port, and draws the attention of market participants to the integration of logistics. At the same time, the concept does not discuss in detail the question of how regionalism affects the development of ports. It also neglects the role played by each of the participants in the process of regionalization, and which port strategy (terminals, municipal management and port cities) should be implemented, in order to control this process [7].

In their paper, the authors noted that there are two main directions of development of the port – as a "pole" and "unit." Under the development of the port as a "pole", the authors understand the development of the port as a “hub” – a point connecting different transport infrastructure. From the point of view of development as a "unit”, the authors understand the port to be one specific facility, formulating trade networks of various sizes for the purpose of goods movement in the hinterland. In the proposed model, however, focus was mainly on the development of the port as a "unit". That means that in actual fact, it was considered to be special case of development, with the characteristic of specialized container terminals involved in the process of the globalization of trade and supply chains [5].

This basic model was quickly copied by followers and imitators, over time becoming more complex and more powerful, finding harmony and intrinsic value of the theoretical constructs. At the same time, they are becoming less and less able to respond to questions about the future development of a specific port.

Gradually it became clear that one universal model of the process of port development can not be created. However, this is not due to a weakness of the conceptual constructs, but the very nature of the phenomenon being studied.

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THE POSSIBILITIES AND USAGE OF DRONES IN INTELLIGENT TRANSPORTATION SYSTEMS

In this review article were considered possibilities of modern drones and their usefulness in intelligent transportation systems based on the publications of reputable sources. Displays General information about the drones and the prospects of their application. A comparative analysis of the legislative framework of various countries for their application.

Keywords: drones, BPLA, ITS, ERTICO, traffic, video recording.

Introduction

Currently, the constant search for new tools capable to perform tasks of intelligent transport systems to an entirely new level. One of these tools considered to be unmanned aerial vehicles, or simply drones.

ERTICO – ITS Europe about the drones

The sector of unmanned aerial vehicles (UAVs often abbreviated) offers a range of new features, referred to frequently in the publish portal ERTICO – ITS Europe (intelligent transport systems Europe).

Fig. 1 – Logo ERTICO

Let me remind you that ERTICO – ITS Europe is an organization, founded in 1991 at the initiative of leading members of the European Commission, the Ministry of transport and the European industry with the aim of development and deployment of intelligent transport systems. ERTICO – ITS Europe is coordinating numerous projects such as HeERO important member of which is Russia. A good example of cooperation is the introduction of the single emergency number 112 in Russia and the establishment of a system of emergency response in case of accidents ERA-GLONASS.

At the end of 2015, the European Parliament discussed about the need for the use of civilian drones, also heard the report about the safe use of unmanned aerial vehicles. After the report was approved, and drones are recommended for safe use, but was noted about the necessity of amendments to the legislative acts.

Drones in the legal field

It is necessary to mention is directly related to drone laws, actively provided worldwide as a consequence of the mass distribution and the need for their safe use.

For example, in Russia after the amendments to the air code of the Russian Federation it is necessary to register drones weighing more than a quarter of a kilogram including toy drones, as well as data about the owner of the drone is transferred to the FSB.

Fig. 2 – The concept of ERA-GLONASS

The strand EC is still no unified law on the use of drones, but in different countries prescribes the need for compliance with a large enough distance to the people, and especially to the crowd of people (for example shooting at a Packed stadium is only possible with removal of more than 150 meters) are prohibited to fly up close to private facilities and airports. It is also necessary in accordance with the weight to obtain a special license.

UK flying drones must be controlled by the civil aviation authority, and in Canada imposed an age restriction 18+. In USA large fines for refusing the registration of any drone up to 27 000 $ (half the average annual income) and the limitation in altitude of up to 122 meters.

The availability of drones

The secret of massive and sudden proliferation of civilian drones lately is their availability. Every year, the price of drones of different classes reduced, and the quality, reliability, features and functions improve. At the end of 2016 games drones from 1,5 thousand rubles, but professional to perform certain functions from 100 thousand rubles (the limit price depends only on the imagination of the buyer) with warranty and service support from the manufacturer.

Fig. 3 – Popular model of civil drone with video camera

The most common drones with electric-powered engines with four blades, a camera, batteries and a controller to control a communication via the mobile operator or the use of radio frequencies with the remote control center. Such drones are often called "quadcopters". The drones also may have the reaction rod (often have drones for military purposes) or from the internal combustion engine to have different power sources and can have various sensors and accessories to expand the feature set. Often installed accelerometers to improve the quality and ease of management.

The possibilities of drones

For the expansion functions can be installed different sensors to test the atmosphere and terrain, which is frequently used by meteorologists, scientists and others. For example UAV is the special equipment your Company uses Google for its Google map service to photograph the area and determine the relief, as the campaign tries to start the constant presence of drones in the air to control the traffic during peak hours.

In 2015 the competition program Mobility IDEA from Siemens took first place decisions on the basis of smart drones to quickly find Parking spaces and Park the car without driver. The jury was struck by the ability to safely perform the operation, and the ability to control the movement using drones and execution of intellectual tasks in automatic mode, seeing all the future development of this method.

Experts believe that the use of drones is necessary in intelligent transportation systems to improve safety and optimize road traffic. In the publish portal ERTICO – ITS Europe was mentioned that drones can be used in near future for total control of the traffic enforcement with video and photofixation violations. Also drones can be used for: the correction in the system of adaptive traffic signals, monitor traffic, record traffic, capture traffic incidents, participate in motor control of ground unmanned vehicles. This will allow to more efficiently manage traffic lights to control speed limits to warn drivers about the dangers in their way, to significantly improve the safety and environmental friendliness, to redistribute traffic flow of busy streets, helping the driver to spend less time in transit.

Fig. 4 – The drone in the service of the EMERCOM of RUSSIA

Compared with classic solutions

The drone as a means to monitor the traffic situation can be compared with the widely used traffic cameras, however they have a number of drawbacks and features.

The installation of traffic cameras is now quite expensive (at least 150 thousand rubles), as its installation will require the involvement of outside organizations having necessary licenses, project creation, project coordination, erection of special supports and often with installing a new camera it turns out that the camera position is not chosen optimally, which significantly reduces the efficiency of the chamber as a whole. In addition to the high cost and high setup time (several months) in traditional traffic cameras there are disadvantages associated with their stationaryty, i.e., camera data does not allow to conduct road facility, without special rotating mechanism, it is impossible to remotely rotate the camera and change the focal length of the lens, which allows to obtain only a stationary picture with a small section of road in the road section.

Of the benefits in favor of stationary cameras include: the ability to install a heavier camera stable connection to the server wirelessly or using wired connection, the possibility of summing the stationary power supply from the mains supply, there is the possibility of lighting at the site in the dark.

Drones provide an opportunity to address some of the shortcomings of stationary traffic cameras and allow police officers to quickly launch drones with cameras and obtaining images of an area of interest, the roads, the operator can, if necessary, easily change the location, change the angle and height of observation, in some cases, it is not obligatory trip to the place to start. The traffic services it is possible to "StaiNo" to conduct surveillance in various places on the type of mobile speed cameras to improve road safety.

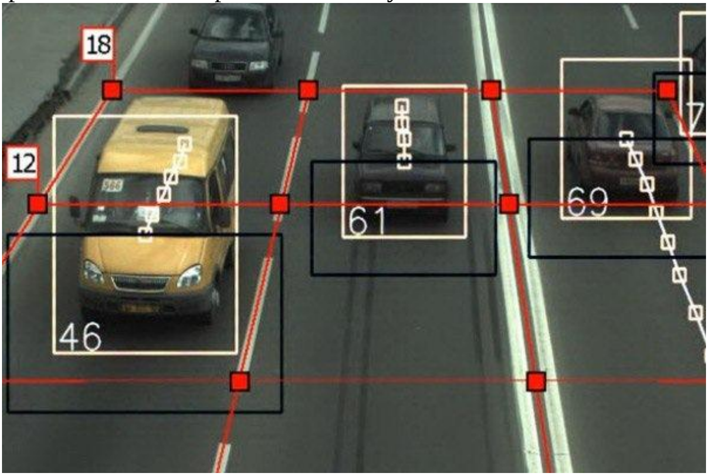

Fig. 5 – Image from the traffic camera

Drones are also capable of conducting objects without losing them from sight at speeds up to 80 km/h of the drawbacks of drones, we note the need to recharge/replace batteries (modern civil drones to 300 thousand rubles is not able to hang in the air for more than 4 hours) and limitations of the characteristics of modern cameras. For example, the camera required illumination area of not less than 5лк to distinguish between object 30лк, and to distinguish between rooms not less than 1500 Lux (the night of the full moon is 0.2 Lux at sunrise 1000 Lux, and the usual light in our latitudes in summer during the day in clear weather, 15000 LX)

For a drone, as with any flying machine required by weather conditions and cannot use them in heavy precipitation and air temperature less than 0 degrees Celsius without the use of special procedures.

Also for fixing the number of the vehicle, you need a minimum distance of 50 meters and a maximum angle of 30 degrees, which makes the lock almost impossible because when a drone hovering at an altitude of 20 degrees at a required distance number of the car at too great an angle will give illumination. Now also in Europe widely used for part of the above functions balloons with attached equipment.

Fig. 6 – Drones in the road services

The main advantage of balloons is almost unlimited stay in the air without energy consumption and main drawback is strong dependence on wind and stationarity. To address these shortcomings, the emphasis is on drones, but they have a strong dependence on the energy source.

Fig. 7 – The balloon EYE-1 for control of observance of traffic regulations

Conclusion

Now a lot of research and testing, aligned legislation for widespread use of unmanned aerial vehicles in intelligent transport systems, opening new opportunities and providing various solutions based on them.

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EVALUATION OF THE TIME PARAMETERS OF CUSTOMS PROCEDURES AT THE SEAPORT FOR CARGO CONTAINERS

Considered the problem of the temporary expenses arising during customs clearance of container in seaport. The main problems requiring a special attention which solution will allow to lower expenses for business are revealed.

Keywords: customs clearance, container, seaport.

Now each freight staying in seaport is subject to control and undergoes the procedure of a customs clearance. Maritime container transports, by right, use special popularity among all international carriages of freights. They proved the reliability throughout the long period, besides, are the most available from the point of view of necessary costs.

According to article 150 of chapter 22 of the Customs Code of the Customs union all goods and vehicles moved through a customs border are subject to a customs clearance and customs control in the order established by the customs legislation of customs union and the legislation of state members of customs union in an order and on conditions which are provided by the Customs Code of the Customs Union.

The fact of an obligatory customs clearance is serious risk for business as because of formalities, sluggishness and possible problems during this procedure contracts can break, be broken flows of commodities that as a result leads to direct losses of entrepreneurs. The customs code regulates terms of a customs clearance of freights. Usually time of customs clearance of freight isn't exceeded by 3-5 working days, but it on condition of accurate and competent execution of all documents, but some moments can cause a delay.

Duration of customs clearance is influenced by correctly constituted and timely submitted cargo customs declaration (CCD). Giving of a CCD in case of commodity import in a container is possible during the whole time of stay of freight in stock of temporary storage, and the moment of the beginning of counting for submission due date of the declaration of goods, day of presentation of the declared goods to customs together of their arrival on the Russian customs area is considered.

The customs finishes the procedure of customs clearance by the decision on release of goods after verification of the provided customs declaration and shipping documents. If necessary, the customs authority, also, checks compliance declared quantitative and quality characteristics of goods by actual. Release of goods shall be finished by customs authority no later than 1 (one) working day following behind day of registration of the customs declaration (the Art. of the Customs Code of the Customs Union No. 196). This term can be extended by customs authority for time required for conducting additional verification of the documents and data declared in the declaration on goods and shipping documents.

The container can be directed by customs authorities to passing Work of a Complex ICC (inspection and customs complex) is based on use of the ionizing (x-ray) radiation allowing to receive the high-quality image of the examined vehicle and freight on the monitor screen. When carrying out IDK opening of a container isn't made. When scanning IDK moves, the checked object remains motionless. The complex allows, having enlarged the image, to draw conclusions on characteristics of freight, to estimate approximate quantity and uniformity of goods, to find the objects forbidden to transportation. Conducting additional check, extends terms of customs clearance.

The maximum time spent of goods for customs, to be exact in the paid warehouse of temporary storage (WTS) – 4 months and 10 days. The actual terms of implementation of a customs clearance average 1 – 4 working day.

Proceeding from practice, it is possible to allocate such basic reasons of increase in terms of customs clearance of imported goods:

• lack of regulation of the financial relations between partners,
• lack of allowing documents of various monitoring bodies,
• mistakes in registration of a packet of necessary documents.

Skilled customs representatives (brokers) usually keep within in 1 – 2 working day. However it depends not only on professionalism of the companies, and on correctness of creation of accompanying and allowing documents on goods their owner, timeliness of payment of customs fees and duties, operational provision of additional documentation to the customs applicant and in customs.

To the main of them, in case of import of product goods of an animal origin belong:

• The agreement in foreign trade, the agreement on delivery, etc.
• Bill of lading.
• Documents based on which the classification code of goods was declared.
• The documents confirming customs payment.
• Ruble or currency payment orders.
• For currency exchange control and determination of customs value of goods – the transaction certificate, and also the documents confirming the declared customs value of goods.
• The documents confirming observance of prohibitions, restrictions and measures of non-tariff regulation (the license for import - commodity export, safety certificates, hygienic certificates, veterinary or phytosanitary certificates, certificates of conformity, etc.).
• The power of attorney on the person which represents the organization in customs authorities.

• Data on the company (a packet of statutory documents, the certificate from tax authorities on registration, the certificate on entering into the Unified state register, the statement (statistics codes), the bank certificate of availability of the settlement account).
• Export declaration.
• Certificate of a form "A".
• The price list provided by the sender.
• Health certificates granted by border control veterinary stations

One more important factor influencing time of passing of customs procedures in seaport are adequate actions of customs authorities for acceptance and verification of the submitted documents and data including confirming observance of the non-tariff measures of regulation established by the legislation of the Russian Federation on state regulation of foreign trade activity, to collection of customs payments, survey and goods inspection and vehicles that is especially urgent for freight to the subject obligatory veterinary examination.

In practice, everything happens in the Russian ports "slowly" - there is no direct economic interest in acceleration of terminal load handling in the course of customs control. Additional expenses for idle time of a container are possible, it can happen in case of "the logistics services which aren't debugged", or because of a queue on the dropped-out survey/examination and time of its carrying out, or because of disagreement of the importer to apply the method of determination of customs value offered by customs and to make the adjustment of customs value (ACV).

The factors listed in this article influencing temporary parameters of passing by freights of customs procedures, in particular in seaport as in the main transport link of a chain of international trade, are the most urgent for the companies performing the activities in the sphere of foreign trade activities.

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INFLUENCE OF LOGISTICS TRANSPORT COMPANIES IN THE QUALITY OF SERVICES

The article discusses the impact of logistics transportation company quality by establishing correspondence between the criteria of quality of services. The evaluation of the quality of the consumer and the company's logistics system. Understanding the mechanisms of influence of logistics on the quality of services can significantly improve competitiveness.

Keywords: transport logistics company, the quality of transport services, quality criteria, model of the company, organization of activities.

All use the services of shipping companies. Transport activity is essentially mediates all other spheres of human activity and an indicator of general trends in [1] economy. The quality of transport services depends on the internal organization of the company prior to the process of service delivery. The basis of the organization of transport companies activity may be on the concept and principles of logistics, affecting the quality of transport services. The mechanism of this influence requires more detailed consideration.

The quality of the transport services can be defined as the extent to which the inherent characteristics (distinctive features) services to the needs or expectations of the consumer [2]. Evaluation of the quality of transport services is based on the criteria in accordance with which their classification or comparison [3]. The basis for the classification below is the classification of the basic criteria of quality of products and services

1. The transportation functionality, i.e. a set of transport features, capabilities as required, and related to additional services. In the case of passenger transport functionality includes the ability to power on long transport, the possibility of the client's sleep, comfortable accommodation and luggage etc.

2. The quality of the vehicles. By this criterion, the quality can be attributed to the safety of vehicle passengers or cargo, as well as its comfort and reliability. Under the reliability refers to the property of the vehicle to keep time within the established values of the parameters characterizing its ability to perform its required function (freight and passengers) in the given conditions and the conditions of application [4].

3. The quality of the consignment (transport of passengers). If we talk about passenger traffic, then here you can include criteria such as the accuracy of the departure (arrival) of vehicles on schedule, transportation speed, travel time, and others.

4. Staff competence. This quality criterion characterizes the level of knowledge and experience of the staff necessary for the implementation of transport services.

5. Courtesy and helpfulness of staff. It can be argued that the quality criteria included in the competence of the personnel. However, the transport company employee can be a specialist of high class in their field, but at the same time and be rude to customers. Often the opposite situation, when the impeccable treatment of staff with customers hides his incompetence.

6. Quality of infrastructure. In the case of passenger transport by road to this criteria include the quality of the quality of coverage of highways, their luminosity, purity in the winter.

According to these criteria, the quality, the consumer compares actual values (indicators) provided him transportation services with their expectations and the proposed price.

All the criteria of quality of transport services can be divided into two groups:

1. External quality criteria that are independent from the organization of the company, providing transportation services. These criteria include the quality of transport infrastructure. On the one hand, transport companies pay the appropriate taxes to the state budget, which in turn should go to building new roads and repair constructed. On the other hand, the situation in this area, you can easily feel when traveling by car.

2. The internal quality criteria, which are a consequence of the internal organization of the company. These criteria are formed as a result of the preparatory to the provision of transport services of the company and appear on the stage of the main activities. For example, for the implementation of transport services, the company must purchase vehicles, hire skilled staff and conduct its training, to organize the supply of fuel and lubricants, and so on. D. These components of the quality of transport services include quality vehicles, transportation functionality, competence of staff, and the quality of delivery of cargo (passenger transport).

Consider the impact of transportation logistics company on the criteria of quality of services presented above.

1. The transportation functionality is rather outside the scope of logistics, as is laid at the stage of market research and the design of future services. But at the stage of vehicle purchases (where the action steps in the procurement logistics), should be taken into account functionality planted earlier.

2. The quality of the vehicles. This quality criterion is greatly facilitated by the procurement logistics company, which is responsible for the acquisition, both the vehicles and for the timely supply of fuel and lubricants and spare parts for vehicles. This activity is largely determines the safety and reliability of the vehicle during operation, that is, the direct process of providing services.

3. The quality of the consignment (transport of passengers) is a central criterion for the quality provided by the system of transport logistics company. As

noted above, this performance criterion characterizes the ability of the supplier to deliver the required load in the required quantity, at the right place at the scheduled time and with minimal costs. With regard to passenger transport, the quality criterion characterizes the ability of the supplier to carry a passenger on schedule, at the right place for the best route for him. Effective organization of this activity relates to the domain of transport logistics.

4. The competence of staff is largely driven by the quality of his training before embarking on the main activity: the provision of transport services. This component is likely part of the corporate culture and is caused by the level of development of personnel training technologies. It can be argued that the quality component is outside the scope of the transport logistics company.

5. Courtesy and helpfulness of staff. Such a quality component is outside the scope of logistics, as these properties are part of the staff of the corporate culture and an indicator of the overall culture of the society.

6. The quality of infrastructure is the "external" criterion of quality to which the company may have only an indirect effect (eg through taxes paid). Therefore, the company's logistics system has no direct impact on ne¸. However, the design of the route of delivery of the goods or the carriage of passengers, it is possible to take into account the state of the transport infrastructure quality. So, get feedback: the quality of infrastructure affects the logistics activities of the company.

As a result, found the two central criterion of the quality of transport services, which are affected by the company's logistics: quality vehicles (procurement logistics) and quality of the delivery of the goods or the carriage of passengers (transport logistics). On all the other criteria of quality, logistics has an indirect influence.

For the impact of logistics companies on the quality of transport services, we can start from a certain model of the company. The model is a useful simplification of reality, intended to address aspects of interest in the framework of a solved problem [5, p. 99]. Each stage of the company is considered in two aspects: work with the tangible and intangible resources. This is a characteristic feature of all services and transport services in particular: while the content of the material and immaterial components of various proportions [6, p. 53].

The first stage (resource procurement) is the company's activities related to the purchase of vehicles, fuel, spare parts, as well as recruitment and acquisition of providing services. By providing services mean the licensing of the right to provide transport services, the achievement of an agreement on the maintenance and repair of vehicles by a third party, etc. Efficient organization of the procurement is carried out in accordance with the principles of the concept of logistics and procurement logistics. Procurement activities of the transport companies is a necessary but not sufficient condition for customer satisfaction quality of transport services.

The second stage (resource conversion) transport company is a set of processes, personnel training, maintenance and repair of vehicles. This could also include the development of the route, according to the logistics concept. All activities at this stage should be considered in the light of subsequent customer satisfaction with transport services.

The third stage (rendering services) is the direct process of transportation of passengers or cargo. At this stage, it appears quality components formed as a result of the previous stages. On the other hand, gross customer service staff (in the case of passenger traffic) can lead to customer dissatisfaction transport services, despite the fact that all the early steps have been implemented at a high level.

The described model clearly shows the impact of transportation logistics company on the criteria of quality of rendered services. In particular, the company's activities in the procurement stage: the acquisition of vehicles, spare parts, fuel and lubricants, carried out on the basis of logistic concepts and principles of procurement logistics, leads to customer satisfaction with the quality of the vehicles. However, purchased in accordance with the principles of procurement logistics material resources, can not lead to customer satisfaction with the incompetent organization in the transformation stage (for example, untimely maintenance and repair). Therefore, activity of the company for the purchase and conversion of resources, stages connected to each other. It is carried out in the framework of procurement and logistics has a direct impact on the component quality for the consumer "The quality of the vehicle."

The company's activities in the resource conversion stages: the development of routes and schedules, schemes of delivery of cargo in intermodal transport, carried out in accordance with the principles of transport logistics, leads to customer satisfaction and quality of transportation of the consignment. But the established routes, schedules, cargo delivery schemes should be implemented at the stage of provision of services. Therefore, the company's activities in the stages of conversion of resources and the provision of services associated with one another, carried out within the transport logistics and has a direct impact on the quality criterion for the consumer: "The quality of the consignment (passenger transport)."

There is an inverse relationship. Thus, the development of routes, schedules and schemes of delivery should be carried out taking into account the characteristics of the infrastructure.

As a result, it can be argued that the quality of transport services is a complex concept, defined by many criteria on which the consumer compares the properties of the transport services rendered to him with their expectations and the proposed price. The concept and principles of logistics to improve the quality of transport services used in the stage of organization of internal activities of transport companies and appear on the stage of direct provision of services for the carriage of goods or passengers. Logistics transport company has a direct impact on the quality of service criteria: quality of the vehicle and the quality of delivery of the goods or the carriage of passengers. The central role of logistics in the quality of transport services is the "pass-through" keeping the quality at all stages of the company.

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MATHEMATICAL MODELS OF TRANSPORT FLOWS IN THE NETWORK

The paper considers the transport systems organized on the principle of "many-to-many", i. e. the systems, when freight traffic from several points of departure must be delivered to multiple destinations. One of the forms improving the organization of such shipments is the concentration of freight flows in the terminal, followed by the delivery of goods to destinations. In these transport systems, the organization and management of traffic uses three main strategies: each point of origin/destination can be connected to only one terminal; each point of origin/destination can interact with various terminals; each point of origin/destination can interact with other points directly. For each strategy, the appropriate mathematical models are presented. The objective function in these mathematical models minimizes total transport costs. The cost of transporting the load unit between the points of origin/destination is the sum of the values between the points of origin/destination and the terminals, as well as between the terminals. The cost of transporting the load unit between the export terminals is lower than that of the transportation of cargo between the places of origin/destination and the export terminals due to the effect of economies of scale. The calculations that determine the effect of economies of scale factor on the total transport costs to deliver goods according to the chosen delivery model are made. The calculations were carried out for 8, 10 and 12 points of origin/destination with a fixed number of export terminals, the total costs were calculated when the factor of economy of scale was changing between 0 and 1 with an interval of 0.1. The amount of cargo and the cost of the load unit were set with random values at a certain interval. The mathematical models were designed in the integrated environment of the development MATLAB using the optimization package CPLEX.

Keywords: many-to-many distribution, hub-and-spoke transport network, integer programming, economy of scale, export terminal.

One of the efficiency increasing forms of multimodal transport organization is the groupage of cargo flows on the territory of the export terminal (ET) with the subsequent cargo delivery to the destinations. Such a transport network infrastructure is known as the Hub-and-Spoke Network [1, 2].

The transport network places cargo flows between the ET, and optimization of such indicators as the economy of scale index, the number of connections between suppliers and consumers, the size of vehicle fleet for regular servicing in all directions is a significant motivation for planning and organizing routes in these systems.

In real transport systems based on "many-to-many" distribution in the management of transport engineering, the three main strategies are applied (Figure 1) [3]):

1. Each point (node) of origin / destination can be attached only to one ET.
2. Each origin / destination node can interact with several ETs at once.
3. Each origin / destination node can interact directly with other points.

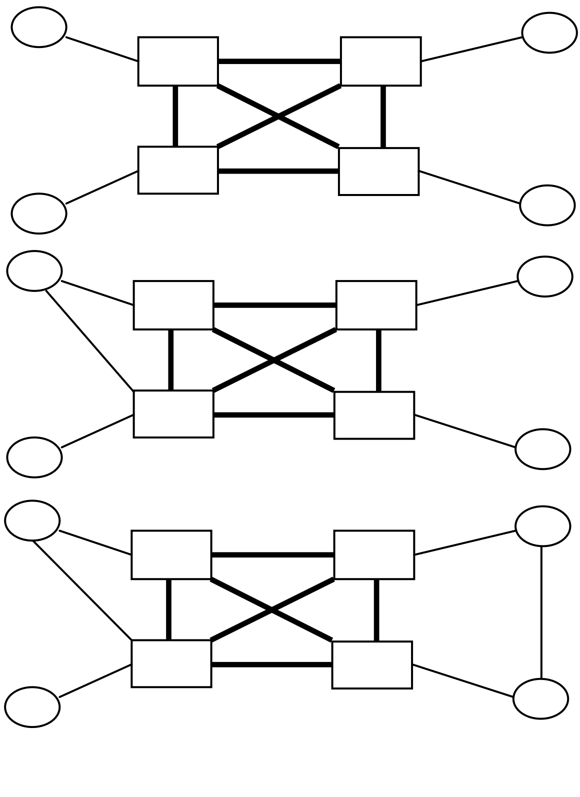

Fig. 1 – Strategies for traffic flows management in the network: o - origin / destination node; □ - export terminal; 1, 2, 3 – transport flows management strategies

Mathematical models of transport flows organization in the network

Model	Objective function	Restrictions
Model 1	$F_1 = \sum_{i=1}^{n}\sum_{j=1}^{n}\sum_{k=1}^{n}\sum_{m=1}^{n} W_{ij} x_{ijkm} c_{ijkm} \to \min$	$\sum_{k=1}^{n} x_{kk} = p$ $\sum_{k=1}^{n} x_{ik} = 1 \ \forall\ i$ $x_{ik} \le x_{kk} \ \forall\ i,\ k,\ i \ne k$ $\sum_{m=1}^{n} x_{ijkm} = x_{ik} \ \forall\ i,\ j,\ k$ $\sum_{k=1}^{n} x_{ijkm} = x_{jm} \ \forall\ i,\ j,\ m$ $x_{ik},\ x_{ijkm} \in \{0,\ 1\} \ \forall\ i,\ j,\ m,\ k$
Model 2	$F_2 = \sum_{i=1}^{n}\sum_{j=1}^{n}\sum_{k=1}^{n}\sum_{m=1}^{n} W_{ij} x_{ijkm} c_{ijkm} \to \min$	$\sum_{k=1}^{n} x_{kk} = p$ $\sum_{k=1}^{n}\sum_{m=1}^{n} x_{ijkm} = 1 \ \forall\ i,\ j$ $\sum_{m=1}^{n} x_{ijkm} \le x_{kk} \ \forall\ i,\ j,\ k$ $\sum_{k=1}^{n} x_{ijkm} \le x_{mm} \ \forall\ i,\ j,\ m$ $x_{ik},\ x_{ijkm} \in \{0,\ 1\} \ \forall\ i,\ j,\ m,\ k$
Model 3	$F_3 = \sum_{i=1}^{n}\sum_{j=1}^{n}\sum_{k=1}^{n}\sum_{m=1}^{n} W_{ij} x_{ijkm} c_{ijkm} + \sum_{i=1}^{n}\sum_{j=1}^{n} W_{ij} x_{ij} c_{ij} \to \min$	$\sum_{k=1}^{n}\sum_{m=1}^{n} x_{ijkm} + x_{ij} = 1 \ \forall\ i,\ j$ Other restrictions are similar to the Model 2 restrictions.

The table presents mathematical models of integer programming for transport network schemes shown in Figure 1 [4, 5, 6], where W_{ij} is the cargo quantity to be delivered from point *i* to point *j*; $x_{ik} = 1$, If the cargo is transported between node *i* and ET located in node *k*, otherwise – $x_{ik} = 0$ (cargo is not transported between node *i* and ET); $x_{kk} = 1$, If ET is located at node *k*, otherwise – $x_{kk} = 0$; $x_{ijkm} = 1$, If the connection between the node *i* and the node *j* is carried out through ET *k* and *m*, otherwise – $x_{ijkm} = 0$; *p* is the number of placed ETs; c_{ijkm} is the cost of transporting the cargo unit between the points of origin / destination and ET (c_{ik}, c_{mj}), as well as between ET (c_{km}), i.e., it is represented as a sum: $c_{ik} + c_{mj} + \alpha c_{km}$, where α is an index of economy of scale ($0 \le \alpha \le 1$); c_{ij} is the cost of transporting a cargo unit along a direct route.

The objective function minimizes the total transportation costs for the cargo delivery from the consignor to the consignee through the ET by means of finding the most efficient structure of the transport network.

Let us consider the influence of the economy of scale index α on the total transportation costs for the delivery of goods, depending on the selected delivery scheme. To determine the total transportation costs, the presented models were implemented and calculated in the MATLAB integrated development environment using the CPLEX optimization package. Calculations were carried out for 8, 10, and 12 nodes with a fixed number of ETs - 3 and 4, the total transport costs were calculated by changing the coefficient α from 0 to 1 with an interval of 0,1. Parameters W_{ij} and c_{ij} are given by random values on a certain interval.

The results of the calculations are shown on Figure 2-4, where the numbers: 1, 2, 3 are the graphs for the models with 3 ET, and the figures 4, 5, 6 are for models with 4 ET.

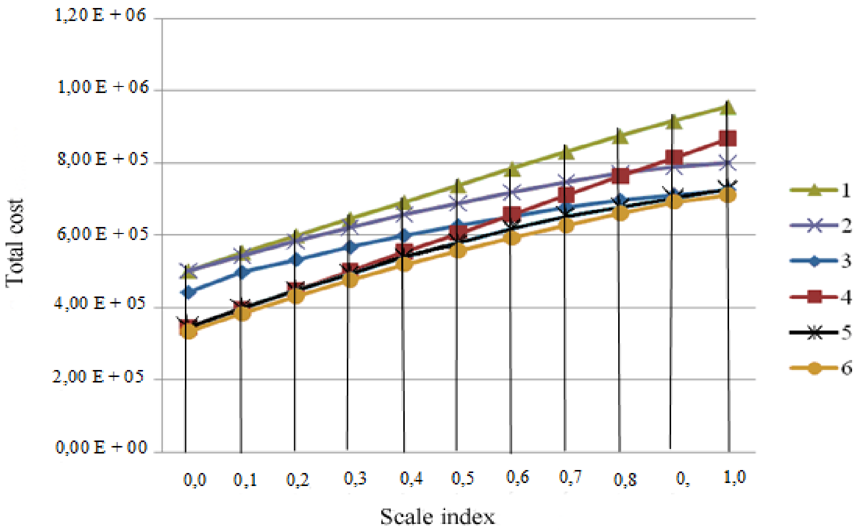

Fig. 2 – Dependence of the total transport costs on α index for 8 nodes

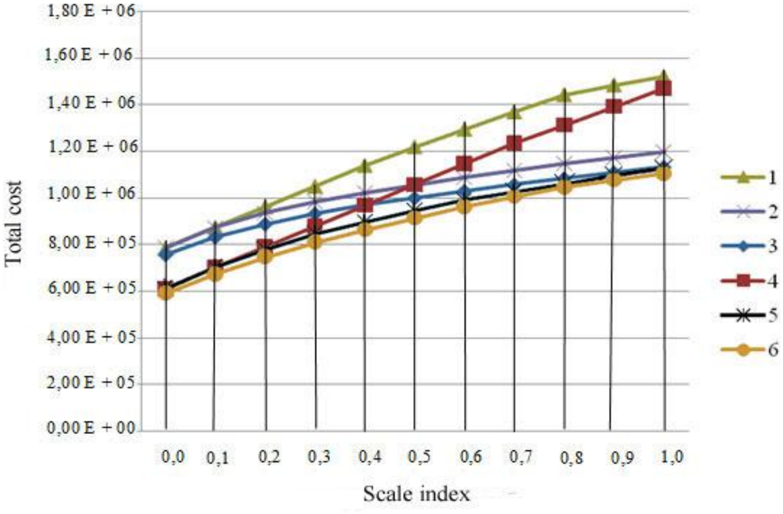

Fig. 3 – Dependence of the total transport costs on α index for 10 nodes

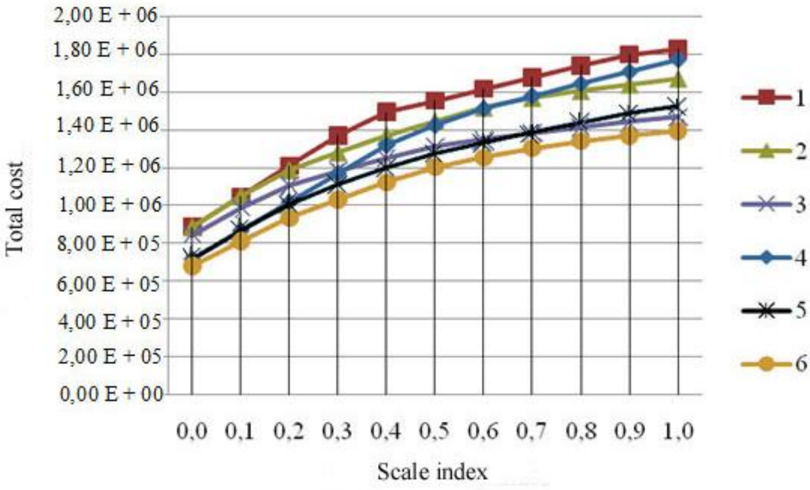

Fig. 4 – Dependence of the total transport costs on α index for 12 nodes

Based on the calculations above, we can draw the following conclusions:

1. In the context of the same amount of ETs, the total transportation costs for a model that allows a direct connection of origin / destination nodes will al-

ways be less than for a model without direct connections and with the possibility of binding a node to several ETs. Thereafter, the costs for the model with the node binding to several ETs will always be less than for the model with node binding to only one ET. Total costs for all three models will be equal only for small values of index α (close to zero). With increasing index α, the difference in cost will increase. Thus, for distribution systems with the number of nodes *n* and the number of ETs *p* and optimal solution F_1, F_2, F_3 for models 1, 2, 3, correspondingly, we can state that $F_1 \leq F_2 \leq F_3$ (table).

This follows from the fact that any feasible solution for model 1 will be a feasible solution for model 2, and any feasible solution for model 2 will be a feasible solution for model 3 [5].

2. For small α indexes, all models tend to use the nearest ETs, with α increasing, the choice of the closest ET to the node is not always optimal. This is true not only for the model with multiple bindings, but also for the model with the node attached to only one ET.

3. With α increasing, the number of nodes attached to several ETs increases. The binding to several ETs occurs even for small α indexes.

4. With α increasing, the distance between ETs plays an increasingly important role in total transportation costs. It leads to changes in the ETs location: the terminals are placed closer together.

5. For low and medium α indexes, the total costs are lower for the first model with 4 ETs than for the second and third models with 3 ETs. Under $\alpha \approx 0,4$ and $\alpha \approx 0,5$ the use of models 3 and 2 with 3 ETs (Figure 5) is more profitable. Thus, with an increase in the transportation cost between ETs, it becomes profitable to reduce the number of ETs and link the node to several ETs with the addition of direct links. In these models it's not taken into account the costs of operation and placement of additional ET, otherwise the total costs for model 1 with 4 ET could be significantly higher.

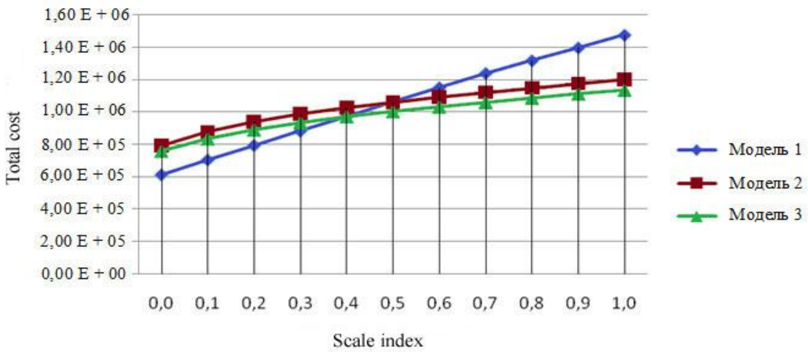

Fig. 5 – Dependence of the total transport costs on α index and amount of ETs for 10 nodes

In models 2 and 3, with α increasing, the emphasis shifts to the predominance of direct routes and routes using one ET. In the case of model 1, the network structure is less sensitive to changes in the cost of transportation between ETs. This conclusion is confirmed by graphs reflecting the number of routes passing between nodes through 1 and 2 ETs, as well as direct routes for 10 nodes and 3 ETs (Figure 6, a-c).

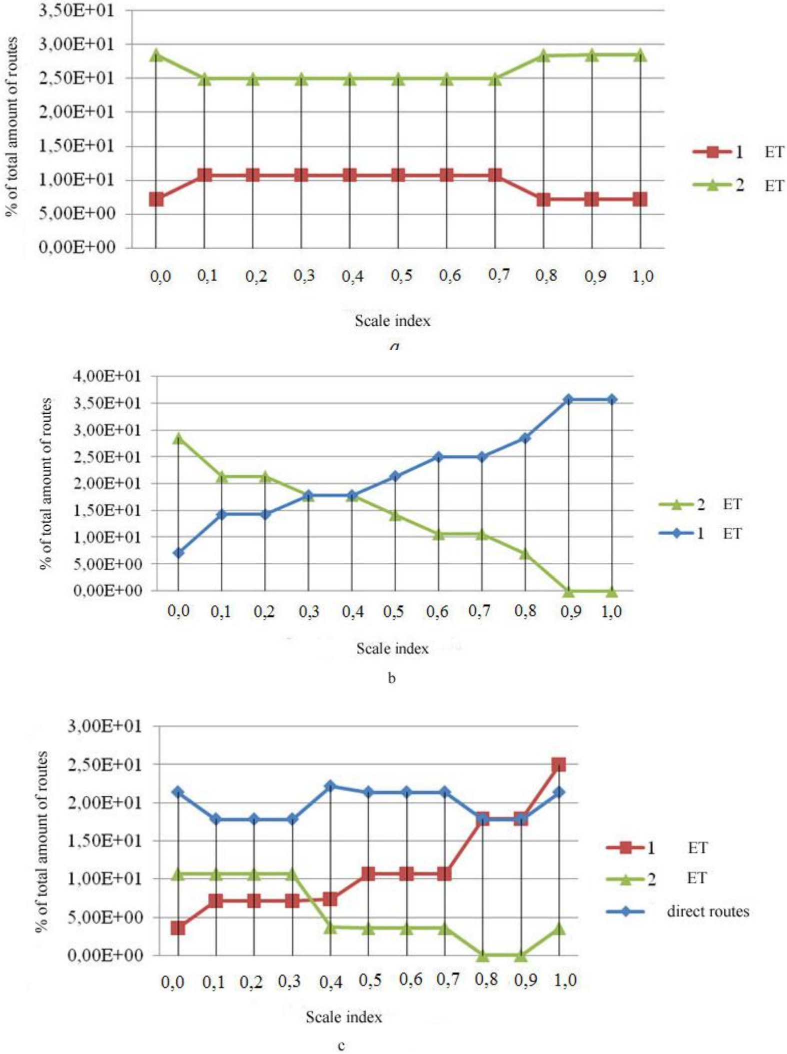

Fig. 8 – Dependence of the amount of routes types on α index: α – for mathematical model 1; b – for mathematical model 2; c – for mathematical model 3

As a result, the above graphs shown that α index significantly affect the optimal binding of nodes to ET. And often at first sight, obvious solutions are not necessarily the best choices; it is equally true for both single and multiple bindings.

Since direct cargo delivery into many remote areas is possible only by air transport, and the delivery of a large number of goods is possible only by sea-vessels or "river-sea" mixed-type vessels through intermediate nodes, to minimize transport costs, it is necessary to use a model without direct connections and with the possibility to bind to multiple ETs.

In addition, in the revised mathematical models it is necessary to take into account the fact that in the real transport system, the nodes with ETs placed in it are defined in advance. Thus, when designing a transport network, it is necessary to consider a model without direct connections, with the possibility of binding consignors and consignees to several ETs and also with a fixed allocation of ET in the transport network.

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FORMULYARIZATION OF CRITERIONS OF THE CHOICE OF SENSOR OF TEMPERATURE AND HUMIDITY CONTROL DURING TRANSPORTATION OF PERISHABLE GOODS

In article are described criteria of the choice of the sensor of temperature and humidity control during transportation of perishable goods.

Keywords: sensor; temperature; humidity; perishable goods; criteria of the choice.

For each consignor, consignee and carrier which is engaged in departure and perishable traffic, especially refrigerator goods, is important to keep temperature and humidity conditions in a vehicle body. It is caused by the fact that all three parties are interested in delivery and receiving goods in a standard type, i.e. to consumers, ready to further sale. If the temperature and humidity conditions are broken, then at participants of process will increase expenses in all supply chain, i.e. finance costs:

– the consignor won't gain the income from the consignee of the spoiled good;

– the carrier will be forced to bear responsibility of a material component, but isn't rare also administrative;

– the consignee won't be able to get profit from sale of the received good or he have to utilize it.

Moreover, none of participants want to lose the clients because of impossibility to organize control of these conditions. All this forces participants to show consideration for observance of this conditions, and, therefore, to choose sensors which will be able quickly provide and write down necessary information about temperature and humidity in a body of the vehicle in which the perishable good is transported.

Now there are a huge number of sensors of humidity and temperature of foreign and native manufacturers in a different price category which are presented at the market of control and measuring devices. Certain pros and cons are peculiar to each sensor of measurement of humidity and temperature. Despite the existing variety of gage of humidity and temperature, the choice of the most suitable of them for specific conditions of operation shall be evidence-based [1]. Therefore there is a question by what criteria to choose the sensor?

As a result of the conducted researches have been formulated 4 big groups of characteristics of sensors, to each of which there corresponds the set of certain criteria [2], [3].

The most important technical parameters which need to be considered at the choice of sensors are presented in table 1.

Table 1 – The most important characteristics of sensors of temperature and humidity

Constructive characteristics	**Measuring characteristics**	**Physical and biological characteristics**	**Economic characteristics**
1) perhaps whether placement of the sensor in the measured environment or good	1) accuracy of measurements	1) the ability to recover from condensation	1) cost
2) the ability to dismantle for calibration or replacement	2) measurement range	2) resistance to chemical and physical contamination	2) maintainability
3) long-term stability of work	3) in what units of measure data are output	3) neutrality to influence of bacteria and a mold	3) interchangeability of the sensor
4) size (dimension)	4) way of information output (on the display, on a thermal paper, in electronic form for viewing on the personal computer, etc.)	4) corrosion resistance	
5) hull strength	5) linearity of output characteristics	5) high resistance to temperature overloads	
6) the possibility of replacing individual parts in case of breakage	6) small time of a response		
7) simplicity of a design			
8) availability of online monitoring system			

Constructive characteristics	Measuring characteristics	Physical and biological characteristics	Economic characteristics
9) area sensor action (using GPS or GLONASS)			
10) possibility of remote control			
11) the possibility of removal of information, including real-time mode			
12) interchangeability of the sensor			
13) measured temperature range			

From table 1 it is visible that a set of characteristics is rather extensive and therefore it is difficult to choose the sensor which would meet all specified conditions. Therefore, it is necessary to mark out the main criteria by which sensors will be compared among themselves.

To be defined what characteristics the most important at the choice of sensors of temperature and humidity, it is possible to use method of expert poll which essence is in that the group of experts has put down points of each of characteristics of the sensor in each of four groups or, for example, has placed them in preference order: from the most important to the least important, in their opinion.

During the poll was used the second method of estimation. The audience of experts is provided by teachers, employees of the logistic companies. After processing of the results, the results were summed up and are formulated the following most priority characteristics for the choice of sensors in each group (see table 2, 3, 4, 5).

Table 2 – The most important characteristics of temperature and humidity sensors, according to expert's opinion. Constructive characteristics

№	Characteristics
1	perhaps whether placement of the sensor in the measured environment or good
2	long-term stability of work

3	hull strength
4	possibility of remote control
5	the possibility of remote removal of information, including real-time mode
6	measured temperature range

Table 3 – The most important characteristics of temperature and humidity sensors, according to expert's opinion. Measuring characteristics

№	Characteristics
1	accuracy of measurements
2	linearity of output characteristics
3	way of information output (on the display, on a thermal paper, in electronic form for viewing on the personal computer, etc.)

Table 4 – The most important characteristics of temperature and humidity sensors, according to expert's opinion. Physical and biological characteristics

№	Characteristics
1	resistance to chemical and physical contamination
2	corrosion resistance
3	high resistance to temperature overloads

Table 5 – The most important characteristics of temperature and humidity sensors, according to expert's opinion. Economic characteristics

№	Characteristics
1	cost
2	maintainability
3	interchangeability of the sensor

After the main criteria of estimation are defined, it is possible to make the comparative characteristic of several sensors of temperature and humidity.

For comparison were chosen sensors, about which it was told in article [4], as well as sensor «ShockLog» Company «SILTEK».

The «ShockLog» – is the electronic recorder, allowing solving complex of problems of control of a condition of good during passing of all logistics chain, namely:

1. To make a record of all inadmissible impacts on freight: blows, vibrations, changes of temperature, humidity, pressure.

2. To provide constant control in real time behind a condition and location of freight (in case of connection of the additional «eTrak» device);

«ShockLog» conducts constant control of external impacts in real time, writes down reports through the established periods or in case of the inadmissible deviations connected with blows, vibration, and inadmissible temperature. The sensor registers impacts on three coordinates that provides a full-fledged picture of monitoring and allows establishing the device, both in horizontal, and in vertical position.

Dust and moisture barrier properties of the housing, allows to install the device even in the open air and in adverse climatic conditions.

Electronic recorder «ShockLog» is available in three versions: «ShockLog 298», «248», «208» (see Figure 1) [5].

Fig. 1 – Electronic recorder «ShockLog» of three modifications

Table 6 – Comparative characteristic of five various sensors

Characteristics	**DataCOLD**	**THERMO-CHRON**	**EClerk-M**	**Logger100**	**ShockLog**
Constructive					
1) perhaps whether placement of the sensor in the measured environment or good	+	+	+	+	+
2) long-term stability of work	+	+	+	+	+
3) hull strength	+	+	+	+	+
4) possibility of remote	+	-	-	-	+

Characteristics	DataCOLD	THERMO-CHRON	EClerk-M	Logger100	ShockLog
control					
5) the possibility of remote removal of information, including real-time mode	+	-	-	-	+
6) measured temperature range	-40…+50	-40…+85 -5…+26	-40…+1200	-40…+70	-40…+85
Measuring					
1) accuracy of measurements	±1C°	±1C°…0,5C°	±0,2C°	±1C°	±1C°
2) linearity of output characteristics	+	+	+	+	+
3) way of information output (on the display, on a thermal paper, in electronic form for viewing on the personal computer, etc.)	thermal paper, computer	at a contact of the special device – the support device probe	display, computer	computer	computer
Physical and biological					
1) resistance to chemical and physical contamination	+	+	+	+	+
2) corrosion resistance	+	+	+	+	+
3) high resistance to temperature overloads	+	+	+	+	+
Economic					

Characteristics	DataCOLD	THERMO-CHRON	EClerk-M	Logger100	ShockLog
1) cost, rub.	60 000 without installation	2 659 (the sensor)	4 446	4 366	10 350 for all compo-nents
2) maintainability	+	+	+	+	+
3) interchangeability of the sensor	perhaps, but other model of the same type	+	+	+	+

Having carried out the comparative characteristic on the chosen sensors, it is possible to draw a conclusion that the most suitable sensor for the Russian carriers of perishable products is «EClerk-M» / «Logger100» or «Shocklog».

The sensor «THERMOCHRON» can be suitable too, but the method of removal of indications can be convenient not to all, and also for its full use it is necessary to buy an addition special device: holder, reader, adapter, receiving device, etc. Therefore, a minimum cost will increase twice.

The «DataCOLD» sensor is generally used only in Europe since it has other than Russia standards of requirements of use. And also high price, as it is used for special refrigerating aggregates, which not all carriers have.

Thus, having carried out rather long and laborious work, we managed to establish the main characteristics of sensors of temperature and humidity which will help further carriers with little effort and costs to determine what it is important for them in case of the choice of the sensor and on what characteristic to put emphasis or what to pay more attention that the choice was acceptable not only at the price, but also on that set of properties which provide sensors.

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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.

Keywords: 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.

Main part

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 clean-up 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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THE IMPACT OF THE DISCHARGE CAPACITY OF THE BULK CARGO POINT ON THE DISCHARGE CAPACITY OF THE DOCK

The evaluation of the use of specialized bulk containers was made for the transshipment of bulk cargo on the not specialized dock by the direct carriage. The methodology for requirement estimation for the intra-port mechanization was presented and the discharge capacity limitations of the increase on the not specialized dock at bulk cargo handling were discovered.

Keywords: bulk container, bulk cargoes, handling technology, transloading terminal.

Up-to-date bulk containers for the bulk cargoes are intended not only for the bulk products carriage, but also for the highly-efficient cargo transfer in the interworking points. The example is the technology of mineral fertilizers transfer from rail to marine transport, successfully used by the Smart Bulk Terminal in the seaport of Ust-Luga. At the same time the specialized bulk container made by the Chinese corporation China International Marine Containers (CIMC) was used. It provides the transfer and storage of cargoes at the same time.

Fig. 1 – The specialized bulk container for the transfer and storage of bulk cargoes

Transfer technology is the order of operations divided by:

- Transfer of the fertilizers from mineral cars into special containers at the loading point;
- Carriage of containers on the dock by the intra-port transport;
- Transshipment of the fertilizers out from the container on to the tramp ship by the mobile crane.

Fig. 2 – Cargo transshipment out of the containers on to the vessel

The key condition for the success of the “transshipment point – dock” system activity is the comparability term of its discharge capacity.

$$P_{DOCK} = P_{LOAD.POINT}^{CONT.},$$

Where: P_{DOCK} is a dock discharge capacity;

$P_{LOAD.POINT}^{CONT.}$ is a discharge capacity of the container loading point (containers per day).

The direct estimation of the transferred containers per day can be evaluated in terms of a correlation between a mobile crane capacity from the dock, intra-port transport performance and containers loading point.

$$P^{CRANE} \cdot m = P^{DIR.CARRIAGE}_{IN.TRANSP.} \cdot M^{DIR.CARRIAGE}_{IN.TRANSP.},$$

$$P^{CRANE} \cdot m = P^{CONT.}_{LOAD.POINT} \cdot n^{CONT.}_{LOAD.POINT},$$

$$P^{DIR.CARRIAGE.}_{IN.TRANSP.} \cdot M^{DIR.CARRIAGE}_{IN.TRANSP.} = P^{CONT.}_{LOAD.POINT} \cdot n^{CONT.}_{LOAD.POINT},$$

Where: P^{CRANE} is an efficiency of the dock mobile crane (containers per day);

m is an amount of the mechanical units;

$P^{DIR.CARRIAGE}_{IN.TRANSP.}$ is an efficiency of the intra-port transport (containers per day);

$M^{DIR.CARRIAGE}_{IN.TRANSP.}$ is an amount of the intra-port transport;

$P^{CONT.}_{LOAD.POINT}$ is an efficiency of the container loading point (containers per day);

$n^{CONT.T}_{LOAD.POINT}$ is an amount of the container loading point.

Then a required amount of the container loading points is:

$$n^{CONT.}_{LOAD.POINT} = \frac{P^{CRANE} \cdot m}{P^{CONT.}_{LOAD.POINT}},$$

while an amount of the intra-port transport is:

$$M^{DIR.CARRIAGE}_{IN/TRANSP.} = \frac{P^{CONT.}_{LOAD.POINT} \cdot n^{CONT.}_{LOAD.POINT}}{P^{DIR.CARRIAGE}_{IN.TRANSP.}}$$

At the same time, under the condition of $P^{CONT.}_{LOAD.POINT}$ and $n^{CONT.}_{LOAD.POINT}$ (i.e. if one uses its full discharge capacity), the amount of the intra-port transport units falls into dependence on the intensity of the working a vessel and it receives the restriction (max) as the multiplication of the intra-port transport product and the amount of containers loading units.

$$M^{DIR.CARRIAGE}_{IN.TRANSP.\ \max} = n^{CONT.}_{LOAD.POINT} \cdot P^{DIR.CARRIAGE}_{IN.TRANSP.}$$

Participation of the bigger amount of the container transport systems will lead to its demurrage at the bulk cargo transshipment point out from the rail transport.

The pictures show that the increasing of the discharge capacity of the bulk cargo transshipment point out from the rail transport in special containers may lead to a reduction of the intra-port vehicles. This reduction, in turn, affects the crane performance and the dock capacity.

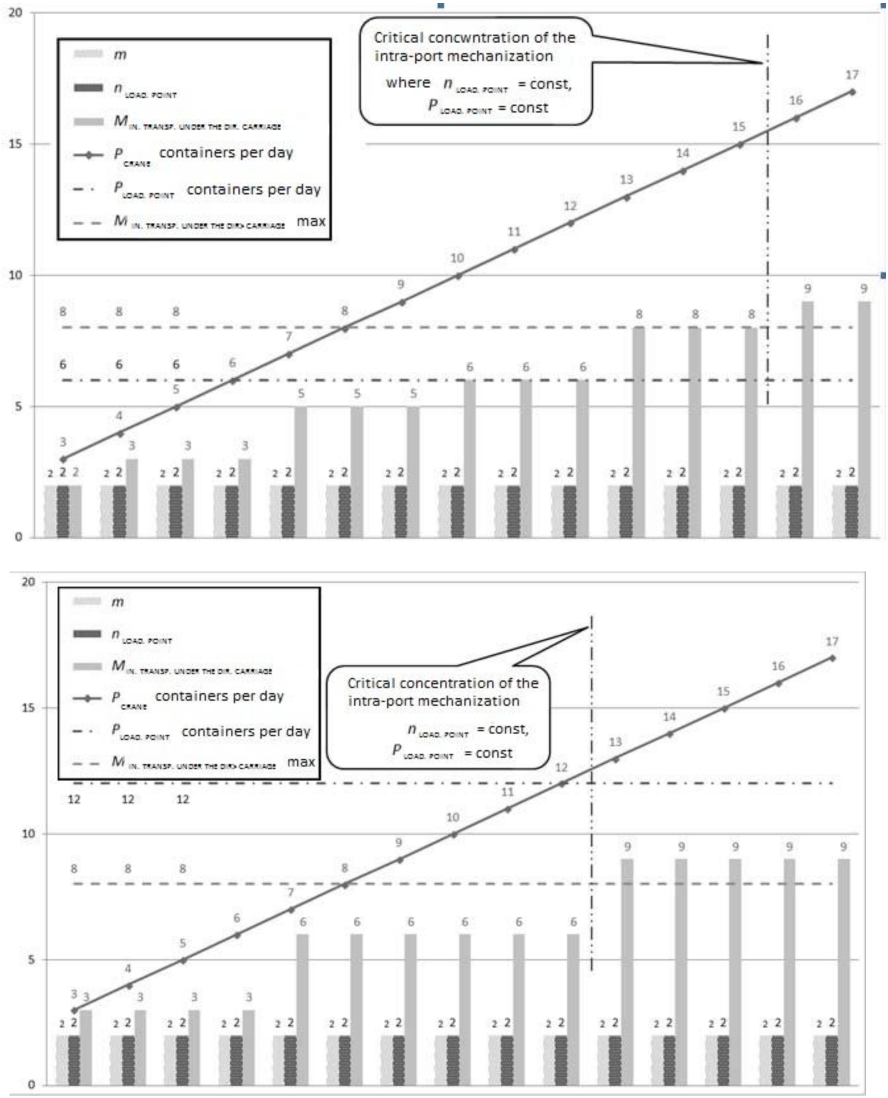

Fig. 3 – The dependence of the amount of the intra-port discharge capacity transport of the container loading points

The pictures show that the increasing of the discharge capacity of the bulk cargo transshipment point out from the rail transport in special containers may lead to a reduction of the intra-port vehicles. This reduction, in turn, affects the crane performance and the dock capacity.

Consequently, the considered problem is undoubtedly of interest to specialists being in charge of the reasonable arrangement of the vehicles and dock mechanization at the work options with the help of the introduction of the new technologies of bulk cargoes transfer in the companies' practices.

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THE SEAPORT OF GDANSK AS THE HUB OF THE INTERNATIONAL TRADE

In the article the analysis of the main characteristics of the port of Gdansk (Poland) was made. The geographical location, the strong and weak economic sides, the main stages of its development, as well as the main cargo transshipment were studied. Also there was concluded whether the port refers to the definition of the port hub.

Keywords: port, logistics, transshipment, transportation hub, container terminal

In this article we will look at the third-largest Baltic seaport: the port of Gdansk (Poland). The port is located in the central part of the southern Baltic Sea coast, in one of the fastest growing regions in Europe and is a major international transport hub. As a distribution center, the port of Gdansk is becoming a major link in the Trans-European sea-lane connecting Scandinavia with the South-Eastern Europe.

The port of Gdansk is formed by two districts: the inner port located along the river Vistula and the canal, and the outer port, which lies near the Gulf. Inner port consists of the following infrastructure facilities: container terminal, passenger ferries terminal and RORO ships, transshipment point for motor cars and food products (citrus fruits), the point for the sulfur processing and other bulk-loaded cargo, phosphorite transshipment point. Other berths equipped with the special equipment and infrastructure, are all-class berths and allow to process conventional and bulk cargo (steel products, heavy and OOG, crops, fertilizers, ore and coal). In the outer port there are wharves, berths, build-up platforms. In this part of the port there are the points for the energy commodities transshipment: fuel oil, coal and liquid gas. In the outer port a modern (Deep-sea Container Terminal – DCT is situated. The two-district port structure allows strengthening the terminals specialization, increasing the number and length of the berths, promoting the effective environmental problems solution due to the ‘dirty’ duties removal to the outer port.

Establishing the efficient transport routes from such port as Gdansk and neighboring Gdynia, may allow to the Polish seaports extending its own hinterland beyond national borders. However, it should be noted that the Polish ports hinterland significantly crosses the attraction zone of the other European ports, especially port’s chain Hamburg – Havre.

The only managerial body of the port is JSC Port of Gdansk Authority – PGA with its registered office in Gdansk. PGA is a trading company established in 1998 and operating in accordance with the Law on ports and harbors, and the Trading Companies Code of the Republic of Poland.

In the recent years, the cargo turn-over of the port has significantly increased: for the period of 2012–2015 the average annual growth was 10.2 %, reaching 35.91 million tons in 2015. The most measurable increase can be observed on the containerized cargo indexes: in the period of 2005–2015 the containers turn-over rose by almost 16 times. The maximum index was in 2014 with 1.21 million TEU, in 2015 the container transshipment capacity of the port decreased by 10 % to 1.09 million TEU (Figure 1).

Table 1

Cargo turn-over of the port of Gdansk (kilotons) Type of cargo	**2012**	**2013**	**2014**	**2015**
Crops	1018	1479	1629	1455
General cargo (incl. wood)	8888	10514	11229	11814
Other dry cargo	4328	2650	3613	3445
Coal	1989	4589	3322	4487
Fuel oil	10741	11026	12483	14710
Total	**26898**	**30259**	**32277**	**35913**

Source: JSC Port of Gdansk Authority

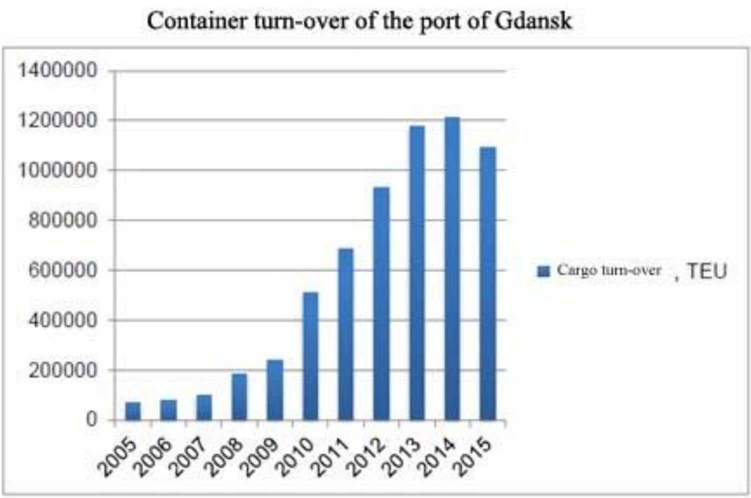

Fig. 1

Since 2010, DCT Gdansk began to accommodate the direct shipping routes of the Danish company called Maersk Line from the Far East to Europe, with vessels carrying up to 8,000 TEU; and in 2011 even larger vessels: Triple-E with the capacity of up to 18,000 TEU.

DCT Gdansk is the only port in the Baltic Sea, the technical characteristics of which make it possible to accommodate Triple-E container carriers with a depth to the point of 16.5 m.

In my opinion, this fact has become one of the most fundamental in making the decision on the inclusion of Maersk Line in Gdansk linear ocean route AE10 from Southeast Asia to Europe (as the final ship entry port). This circumstance has allowed the port of Gdansk to begin specialization in the operation of transshipment and transit in Russia, Sweden, Finland and the Baltic countries.

With the introduction of the Maersk Line direct vessel calls, the level of transshipment has risen sharply in the port of Gdansk. The port, in fact, has become a hub, the majority of processed cargo in the DCT Gdansk had the country of origin (for export) or country of destination (for import) other Baltic countries, mainly Russia and Finland. The percent of the cargo transshipment in the total cargo turnover of the port Gdansk has highly increased: in 2004 the part of transit cargo passing through the port, according to the experts, was 5.0 %, in 2008 this figure rose to 31.0 %, and in 2012 those cargoes were already 60,3 %.

Let us consider how the port of Gdansk corresponds to the concept of port-hub.

Table 2

Aspect	**Variable**	**Port hub**
Location	Sea network Back network	Corresponds Strategic location on the main routes of the sea network and the vast back area of the cargo gravity
The role of the hinterland	Transshipment (sea/sea)	Corresponds 60,3%
	Hinterland coverage	Corresponds More than 500 km is The territory of Poland, Ukraine, Belarus, Russia, Slovakia, Hungary
	Multimodal connections (% of the total cargo capacity)	Corresponds Railroad: 43 %, motorк car: 57 %
Service characteristics	Vessel size	Corresponds The biggest vessel is 18 thousand TEU

Aspect	Variable	Port hub
	The service frequency of the route lines: South-East Asia, and the vessels of more than 13 thousand TEU.	Corresponds 2 (Domination of the Maersk Line, a weekly service of AE10 Shanghai - Gdansk)
	The capacity of the container flow	Corresponds 1,1 million TEU

Source: made by the author

We can conclude that the PGA port of Gdansk works as a hub: it has a strategic position on the main routes of shipping companies; a distinct role in the Marine Network; a high level of transshipment and it can accommodate larger vessels than the region neighboring ports. The port is regularly entered by Maersk Line vessels.

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THE CONSTRUCTION OF A SITUATIONAL MODEL (DYNAMIC) BASED ON THE BAYESIAN APPROACH

The structure of Bayesian networks is reviewed. In diagnostic considerations, the probability values for the goal variables are estimated, the most probable states are determined. The main goal of the modeling is to build a Bayesian network in which all the composite competences are the parent nodes for competences, and all simple competences are parents for competency oriented assignments.

Keywords: Bayesian networks, information technologies in solving research problems, a prior probability, the probability of occurrence of certain events.

Bayesian networks are a convenient tool for describing quite difficult processes and events with uncertainties. To describe the Bayesian network, it is necessary to determine the graph structure and the parameters of each node. This information can be obtained directly from the data or from the expert assessments.

In this paper we describe the process of constructing a Bayesian network for its modeling [1].

The main stages of this process are identification of variables, definition of structure, and definition of parameters.

After the Bayesian network is designed, one can perform calculations with its help. After some evidence entry, posterior probabilities can be calculated.

In the Bayesian network constructed for modeling, there are two basic methods of conclusion: diagnostic reasoning and predictive reasoning.

Diagnostic reasoning evaluates the probabilities for the goal variables, determines the most probable states. The main goal of competence modeling is to build a Bayesian network in which all compound competences are the parent nodes for competences, and all simple competences are parents for competence oriented assignments [2]. In this regard, we note the properties of the relationship between competences important for building a competence model. These properties include: hierarchy, equivalence, aggregation, community and convention.

The article describes the general scheme of work with the list of competences, which are formulated in the standard of the training program. An example of an assessment of the level of competence formation is reviewed.

The Bayesian network (trust) is an acyclic oriented graph in which each node (node of the network) represents an n-valued variable, the arcs denote the existence of immediate cause-and-effect relationships between the connected variables, while the strength of these relationships is expressed in the quantified form of conditional probabilities compared to each variable [3].

Bayesian networks are one of the types of probabilistic graphic models. A rigorous formal definition and theory of Bayesian networks of trust are built and developed in the papers. Bayesian networks are a convenient tool for describing quite difficult processes and events with uncertainties. The basic idea of building a network is the decomposition of a complex system into simple elements. To combine the individual elements in the system, the mathematical tools of probability theory is used. This approach provides an opportunity to build models with a set of interacting variables for the subsequent development of efficient algorithms for data processing and decision making.

From a mathematical point of view, a Bayesian network is a model for representing probabilistic dependencies, as well as the absence of these dependencies. To describe the Bayesian network, it is necessary to determine the structure of the graph and the parameters of each node. This information can be obtained directly from data or from expert assessments. This procedure is called Bayesian Network Training.

Bayesian approaches to building models are classified into three types. The first type of models is the model in which experts determine the network structure, as well as the initial and conditional probabilities. The second type is models focused on maximizing efficiency by limiting the network structure. The third type is data-based models that use data from previous experiments to generate a network structure and probability values. The attractiveness of Bayesian models lies in its high productivity, and also in an intuitive representation in the graph form.

Let us consider a Bayesian network in which competence is checked by a single task. The corresponding network is shown in Figure 1. At the A node is information about the competence formation, and at the a1 node is the result of the task execution. For simplicity, let us consider the case where at the A node the variable may take the value "formed" or "not formed". In this case, the task is evaluated as follows: either "completed" or "not completed".

Fig. 1 – Bayesian network where A competence is checked by one a1 task (developed by the author)

Let us suppose that the following data is given:

1. The conditional probability of the correct answer to the task, provided that the competence is formed – 0,95 (taking into account the possibility of a miss). P (a1 = "completed" | A = "formed") = 0,95.

2. The conditional probability that the task is completed right, although the competence is not formed – 0.2. P (a1 = "completed" | A = "not formed") = 0.2.

Let us consider an example that illustrates the basis for using the Bayesian network to assess the formation of competence. Let the initial (a prior) probability that the competence is formed, is equal to 0.5. P (A = "formed") = 0.5. This means that we do not have any assumptions regarding the formation of competence, i.e. that it corresponds to a state of total uncertainty. Hence we can calculate the probabilities for a1 node, namely p (a1 = "completed") and p (a1 = "not completed").

It is obvious that p (a1 = "is completed") + p (a1 = "not completed") = 1

At that, p (a1 = "completed") = 0.575 p (a1 = "not completed") = 1 - p (a1 = "completed") = 0.425.

In this case, a posterior probability of competence formation can be calculated, i.e. P (A = "formed" | a1 = "completed") is calculated. P (A = "formed" | a1 = "completed") = 0.826

The probability of 0.826 is quite high, and it is much higher than the original probability of 0.5. However, this probability is still far from 1 in view of the fact that there is a possibility of guessing.

Let us now consider the case in which the task is incorrect, i.e. we get the certificate a1 = "not completed". In this case, a posterior probability of competence formation can also be calculated, i.e. the value of p is calculated (A = "formed" | a1 = "not completed"). P (A = "formed" | a1 = "not completed") = 0,059

Thus, there remains a small possibility that competence is still formed, i.e. there was a miss. If, for example, p (A = "formed") = 0.9

If the task is performed correctly, the confidence that the competence is formed is very close to 1. p (A = "formed" | a1 = "completed") = 0.977

In the case of an errors, there is a fairly high probability that competence is not formed. P (A = "formed" | a1 = "not completed") = 0.36

From the example we can draw the following conclusions:

1. if competence is checked by one task, the prior probability of the formation of competence significantly affects the apostorior probability. In this regard, it is necessary to increase the number of tasks;

2. to ensure that judgments about the formation of competence were more reliable, i.e. probability was approaching 0 or 1, it is necessary to reduce the probability of a miss and guessing.[5]

When building a Bayesian network for modeling, it is important to consider the following properties:

- a Bayesian network is an oriented acyclic graph. The nodes of the Bayesian network are connected in pairs with each other by oriented ribs. In this case, there are no cycles in the graph consisting of oriented edges;
- the graph nodes are variables from the model, i.e. some features, for example, levels of competence formation and assessment for the performed competency oriented tasks. These signs can be continuous or discrete. In modeling, discrete data is used more often, because it, if necessary, is sampled when preprocessing educational data;
- for any two nodes of a Bayesian network X and Y, if the edge is directed from X to Y, then X is called the parent of Y. Moreover, any node can have several parent nodes. In turn, the parent node can be one for one or more nodes;
- all nodes that have parent nodes are defined by a table (or function) of conditional probabilities. This allows us to formalize the reasoning about the formation of competence as follows: if the person carrying out this task has competence, then he will perform the task corresponding to this competence. Thus, the conditional probability for the task can be given, if the competence is formed.

If parents (X) is the set of parent nodes for the node X in the Bayesian network, then X is characterized by the distribution of conditional probabilities P (X | parents (X)), which quantifies the influence of the parent nodes on the node X.

If a Bayesian network with random elements X = {X1, ..., Xn} is given, then its joint distribution is defined by the formula:

$P\ (X1, \ldots Xn) = \Pi P\ (Xi \mid parents\ (Xi)\ i\ i = 1$ (1)

Formula (1) allows calculating the marginal probability of any combination of the values of the variables of the set X. In addition, receiving a certificate of a set of values obtained by some network variables, one can calculate the conditional probability of any values combination of other variables in the network using the Bayes theorem.[4]

- For nodes that do not have parent nodes, the probabilities are unconditional (marginal). In other words, if the node X does not have parents, then the probability distribution in it is unconditional, otherwise it is conditional. The probability is determined by the formula:

$P\ (Xi \mid parents\ (Xi) = P\ (Xi)$ (2)

- if the value in the node is obtained as a result of experience, then the node itself is called a witness, and the result of such experience is a testimony. Thus, relations in a correctly constructed Bayesian network determine the conditional dependence of the variables.

Thus, relations in a correctly constructed Bayesian network determine the conditional dependence of the variables.

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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 modelling. The designed model is proved to be adequate by means of queueing theory. Concerns of correlation between vessel distribution mechanism, cargo turnover and port performance indicators are discussed.

Keywords: simulation modelling, queues modelling, prototyping, adequacy proof.

Introduction

Simulation modelling appears to be one of the most effective ways of evaluating performance of complicated systems. The issue of simulation modelling 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 modelling.

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 queueing 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.

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.

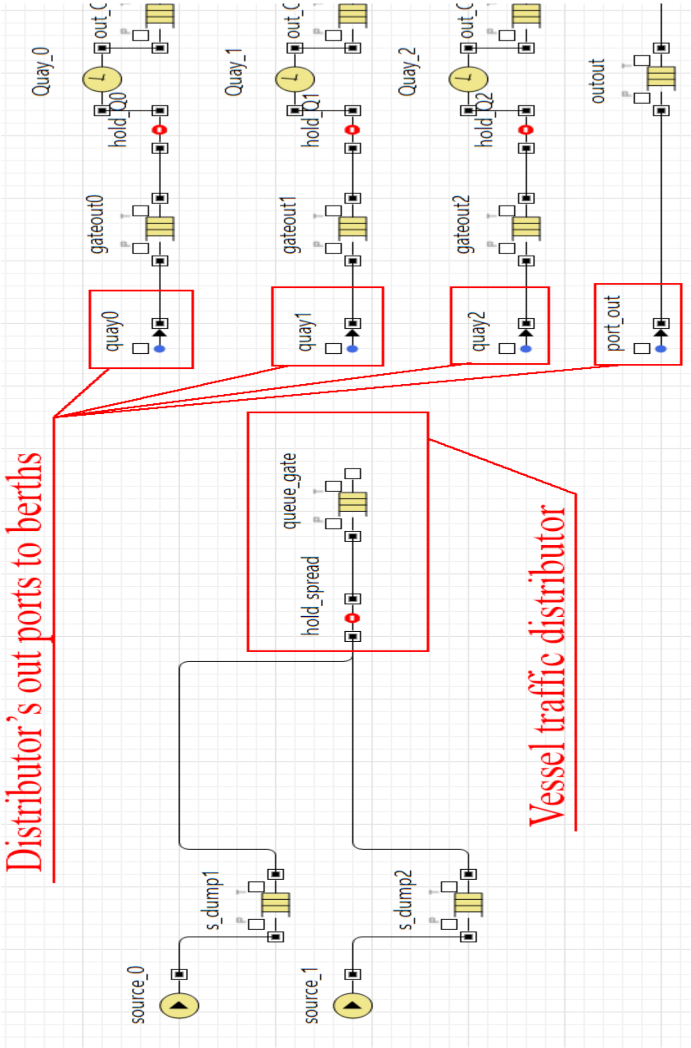

Fig. 1 – Model's logical structure

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.

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.

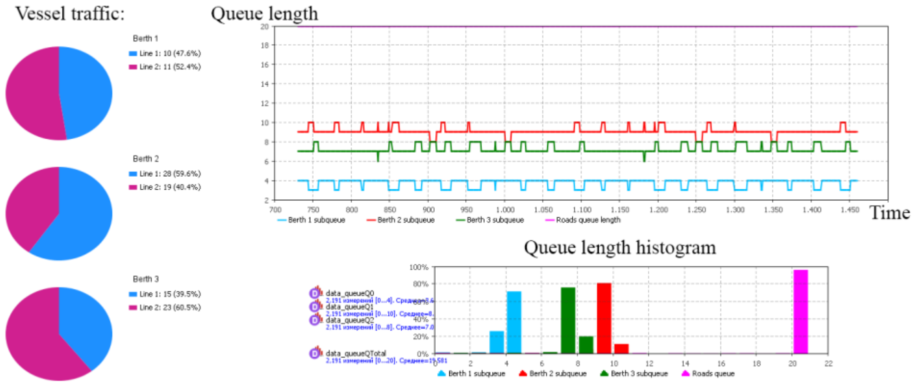

Fig. 2 – Example of experiment results

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