DEPÓSITO LEGAL ZU2020000153
ISSN 0041-8811
E-ISSN 2665-0428

Revista de la Universidad del Zulia

Fundada en 1947
por el Dr. Jesús Enrique Lossada

Ciencias del Agro, Ingeniería y Tecnología

Año 14 N° 39
Enero - Abril 2023
Tercera Época
Maracaibo-Venezuela

DOI: http://dx.doi.org/10.46925//rdluz.39.22

Technological proposal for the attention of the risk in the management of the work of a railway station with a port

Hanna Sergiivna Baulina *
Hanna Yevhenivna Bohomazova **
Svitlana Mykolaivna Prodashchuk ***

ABSTRACT

The purpose of the article is to define an improved technology for managing the operation of a railway station with a port when carrying out container transportation with the attention of the financial risk. To achieve this goal, the authors used methods of statistical data analysis of dynamically changing parameters, methods of mathematical statistics, probability theory, methods of optimization and combinatorial analysis. The article formalizes the technology of managing the work of a railway station with a port in the form of a mathematical model. The objective function of the model is based on the sum of operating costs and takes into account the risk of financial losses of the port station due to the occurrence of risky events that threaten the stable and safe operation of railway transport in the conditions of martial law. For representation of the level of financial risk, the use of the density function of the normal distribution law is proposed. The application of the proposed mathematical model will allow to determine the optimal size of a batch of large-tonnage containers intended for loading onto a ship with minimal operating costs.

KEY WORDS: Railway stations, management, containers, risk management, optimization.

*PhD in Technical Sciences, Associate Professor at the Department of Freight and Commercial Management of Ukrainian State University of Railway Transport. ORCID ID: https://orcid.org/0000-0001-8464-1507. E-mail: baulina777@gmail.com

**PhD in Technical Sciences, Associate Professor at the Department of Freight and Commercial Management of Ukrainian State University of Railway Transport. ORCID ID: http://orcid.org/0000-0002-8042-0624. E-mail: annabogomazova1234@gmail.com

***PhD in Technical Sciences, Associate Professor at the Department of Freight and Commercial Management of Ukrainian State University of Railway Transport. ORCID ID: http://orcid.org/0000-0002-7673-3863. E-mail: sp7728@ukr.net

Recibido:03/10/2022 Aceptado: 06/12/2022

DOI: http://dx.doi.org/10.46925//rdluz.39.22

Propuesta tecnológica para la atención del riesgo en la gestión de obra de una estación ferroviaria con puerto

RESUMEN

El objeto del artículo es definir una tecnología mejorada para gestionar la operación de una estación ferroviaria con puerto al realizar el transporte de contenedores, teniendo en cuenta el riesgo financiero. Para lograr este objetivo, los autores utilizaron métodos de análisis de datos estadísticos de parámetros dinámicamente cambiantes, métodos de estadística matemática, teoría de la probabilidad, métodos de optimización y análisis combinatorio. El artículo formaliza la tecnología de gestión del trabajo de la estación portuaria en forma de modelo matemático. La función objetivo del modelo se basa en la suma de los costos operativos y tiene en cuenta el riesgo de pérdidas financieras de la estación portuaria debido a la ocurrencia de eventos riesgosos que amenazan la operación estable y segura del transporte ferroviario en las condiciones de la ley marcial. Para visualizar el nivel de riesgo financiero, se propone utilizar la función de densidad de la ley de distribución normal. La aplicación del modelo matemático propuesto permitirá determinar el tamaño óptimo de un lote de contenedores de gran tonelaje destinados a ser cargados en un buque, con los mínimos costos de operación.

PALABRAS CLAVE: Estación de tren, gestión, recipientes, gestión de riesgos, optimización.

Introduction

In the current conditions of unstable economic situation and rather fierce competition in the field of transport, the introduction of a customer-oriented approach and improving the quality of services at all stages of freight transportation is crucial. However, lack of coordination between the participants in the transport process at all technological levels leads to violations in the technology of stations and ports, irrational use of reserves of capacity and processing capacity of railways and maritime transport and, consequently, violations in the technology of container traffic. Railway customers are served unevenly. Both railways and freight owners suffer losses due to unproductive downtime of stations, increased operating costs and reduced customer attractiveness, ie lack of competitiveness.

To ensure the effective operation and integrated development of the transport industry as a whole, it is necessary to take into account various factors and risks affecting the number of services and their quality, economically evaluate options for technical and technological improvement of technological management of railway station and port.

DOI: http://dx.doi.org/10.46925//rdluz.39.22

During the state of war, which has been introduced in Ukraine today, there is a constant probability danger of loss and damage to railway transport due to shelling and destruction, and as a result of power outages, accidents, fires, explosions and human casualties. Therefore, it is now necessary to take into account the risks that threaten the stable operation of railways.

Thus, an urgent task is to improve the technology of interaction between the station and the port while focusing on meeting the needs of consumers of transport services. This approach will allow you to find optimal solutions to increase competitiveness and implement a strategy of customer focus.

In this regard, the aim of this study is devoted to determine an improved technology for managing the work of a railway station with a port when carrying out container transportation with the attention of the financial risk.

1. Literature review

To solve the problem of development of transit traffic through port stations of Ukraine Butko and Vergeles (2016) proposed a model for choosing a strategy for the distribution of empty cars in the railway-water junction, the use of which will allow operational staff to establish and choose a rational process in specific transport conditions.

The technology of interaction of sorting and port station in the service of export car flows requires consistency of application of technical means and capacities of the station. Rational use of the number and capacity of station tracks, shunting locomotives, reducing the time to perform various technological operations in the system of interaction of the sorting station with the port station and seaport determine the efficiency of the transport system (Shelekhan and Prodashchuk, 2017).

Baulina and Bohomazova (2020) formalized the technology of the station in interaction with the port in the form of a mathematical model that takes into account the minimum operating costs per car for the period of its stay in the system when performing all necessary operations. The objective function of the model is given in the form of an integrated criterion of quality of car traffic management for a certain period, the value of which will assess the quality of operational staff in car service, track the dynamics of cost reduction operations and identify ways to reduce them.

DOI: http://dx.doi.org/10.46925//rdluz.39.22

Chislov et al. (2020) formed a model of the transport process in the form of a two-criteria problem of integer mathematical programming. Using the model will ensure finding the optimal plan of grain cargo flows according to two-time criteria.

In their study Sansyzbajevab and Mezitisa (2017) developed a simulation model of multimodal transportation processes for process forecasts and evaluation of quality indicators of port stations and terminals. Process modeling is performed using a tool for modeling material flows and cargo units from entry to exit the system. The greatest effect in reducing the downtime of cars at the station was achieved with the coordinated management of trains, the smooth operation of the transport hub and the use of additional locomotive.

For a clearer organization of the transportation process, Butko et al. (2019) reflected the technological process of cargo transportation in the direction in the form of an optimization mathematical model of the process of moving cars. The target function of the model takes into account possible delays in the first and last miles with the probability of financial risks in the form of payment of fines for late delivery of goods.

Nagornyi and Orda (2018) determined the optimal level of reliability of the intermodal container transportation system on the international route China - EU countries both in individual modules and in the system as a whole when applying the profile of rational strategies of transport services for cargo owners.

Koyuncu and Tavacıoğlu (2021) made a scientific contribution to improving the accuracy of the forecast of probable volumes of container traffic in the port of Shanghai The authors managed to achieve this by using two different approaches to time series modeling. As a result of the analysis of time series, scientists have chosen the SARIMA model, which can be used to predict future values, because the accuracy of the forecast, in this case, is more acceptable. This approach can be useful for the rational use of seaport infrastructure.

Matsuda et al. (2021) studied the monopoly of the container transportation market. The authors use an econometric approach to study the extent of market competition. Research indicates differences in the incomes of transport companies, and some of them have large debts and are in a difficult financial situation. Competitiveness of the container transportation market in the conditions of the alliance is considered in the work Hirata (2017). The emergence of large alliances brings a constant increase in the size of the ship,

DOI: http://dx.doi.org/10.46925//rdluz.39.22

which leads to a constant reduction in production costs. However, a large alliance cannot raise the freight rate and does not hinder competition, but rather is a solution to reduce unit operating costs, and therefore to support the container shipping industry.

Peng et al. (2019) proposes a model for optimizing intermodal transportation of loaded and empty containers in hinterlands, which aims to maximize the profits of the transport company, taking into account certain restrictions in container traffic. However, in their article Zhao et al. (2020) formed a multi-purpose optimization model to minimize the total costs in the process of transporting containers in the organization of intermodal rail and water transport. An improved genetic algorithm was used to solve the model.

To distribute international container cargo, Shibasaki and Kawasaki (2021) developed a two-layer network model that includes both global maritime and local domestic transport network in terms of shippers. Baulina et al. (2022) formalized rational technology of servicing freight points of railway tracks of industrial enterprises in the form of a mathematical model that uses the criterion of total operating costs and takes into account the probabilistic nature of waiting time for wagons to supply freight stations. The model is designed to determine the rational number of cars in the supply to the freight point of railway tracks of industrial enterprises.

Bulgakova (2016) considered the interaction of railway transport and transport of industrial enterprises. A real-time freight flow management model in an integrated production and transport system is proposed, which provides a reduction in logistics costs. But only the determined mode of operation of the system is considered and the risks that arise in the work are not taken into account.

The problem of planning the operation of railway stations has many factors of uncertainty (Guo et al., 2016). Therefore, finding an effective and accurate planning method has always been a challenge in this area. The authors propose a unified method of modeling, but does not take into account the interaction of different modes of transport and risks in the work.

Andrić et al. (2019) considered critical risks in railway projects. A total of 24 potential risks in railway projects have been identified, which are divided into 6 groups. A questionnaire is proposed to collect data on the probability of risks and their impact. To identify critical risks in railway projects, a method based on fuzzy and sensitive analysis has

DOI: http://dx.doi.org/10.46925//rdluz.39.22

been developed and applied to risk assessment. The results show that the most critical risks in railway projects are design changes, design errors, credit risk, difficult geological conditions and geopolitical risk. But the risk in the interaction of modes of transport is not taken into account. Financial risk for customers is also not taken into account.

Staznik et al. (2017) note the significant interdependence of transport chains in their interaction, which are a number of links and operations that must be performed in a certain order to ensure optimal technology. It is noted that there are a significant number of risks that negatively affect the optimal functioning of transport systems. A number of steps have been proposed to minimize the negative impact of risk on the efficient operation of transport.

Thus, the existing research is aimed at improving a certain part of the technological process of the port station. At the same time, the full cycle of container wagon handling at the port station during intermodal transportation and possible financial risks have been insufficiently studied. Therefore, it is advisable to study the process of container traffic management when changing the mode of transport from rail to sea, taking into account delays that may occur during processing of container traffic at the port station and port and lead to possible financial losses.

2. Methodology

The tasks set in the work were solved with the help of the appropriate mathematical apparatus and research methods. Were used the methods of processing statistical data and analyzing the data of timing observations when determining the duration of the main technological operations and their expectation. To formalize an improved the technology for managing the work of a railway station with a port, the principles of an integrated approach, methods of optimization and combinatorial analysis are used to take into account parameters that change depending on time. Methods of economic analysis were used to assess the effectiveness of the technology of the system under study.

Probability theory and methods of mathematical statistics were used to determine the risks of financial losses. The degree of impact of risk events on the main performance indicators of the railway station and port was assessed. After that, a conclusion was made about the expediency of taking this risk event into account during modeling. Determination of optimal solutions for managing the operation of the railway station with the port in the

DOI: http://dx.doi.org/10.46925//rdluz.39.22

organization of container transportation is based on the principles of stochastic programming.

The application of the mentioned methods in solving the actual task of improving the technology of managing the work of the port station during container transportation, taking into account occurrence the risks of obtaining additional costs during cargo processing, made it possible to determine the most effective mode of operation of the railway station and the port while ensuring minimum operating costs in modern conditions.

3. Results and Discussions

Port railway stations are an element of the transport system that ensures the interaction of railway transport and sea ports. The efficiency of their work determines the coherence of all links of the production process of transport enterprises as a whole.

One of the main problems in the organization of mixed transportation with the participation of railway transport and sea port is to ensure effective interaction of transport flows of adjacent modes of transport. If the interaction is not clear enough, there may be an additional queue of vehicles waiting for an adjacent mode of transport or due to the lack of cargo in the warehouse or free storage capacity. The specified delay can lead to a violation of the contractual terms of cargo delivery or traffic schedules, which negatively affects the quality of work of the transport and logistics chain and the competitive position of the port terminal operator.

The functioning of railways in the conditions of martial law requires the effective use of all available technical resources, taking into account transport risks, because the probability of increasing damage and losses from military events is constantly increasing. The factors that influence the increase of risks in modern conditions during cargo transportation are identified: increased traffic intensity, speed of transportation, proximity to the combat zone, climatic conditions (air, water and snow loads), a very high level of wear and tear of rolling stock and railway infrastructure and a low level technical equipment of railway transport due to destruction and impossibility of full recovery. Therefore, in the conditions of martial law, the problem of the most accurate determination of possible risks and the assessment of the extent of losses as a result of their occurrence increases significantly. Consideration risks when determining the optimal technology has a

DOI: http://dx.doi.org/10.46925//rdluz.39.22

significant economic effect and increases the level of safety during transportation not only by rail transport.

An important component of the interaction of rail and sea transport is the organization of the process of cargo transportation in containers. The duration of this process is affected not only by the perfection of technical support work, but also by minimizing downtime while waiting for the execution of technological operations.

Today there is a tendency to increase the volume of processing of export cargo in containers (Figure 1). The leader of container circulation in Ukraine, Odessa Sea Port, was selected for the study. It processes containers coming from the Odessa-Port port station of the regional branch «Odessa Railway». The station and port serve mostly 20- and 40-foot containers.

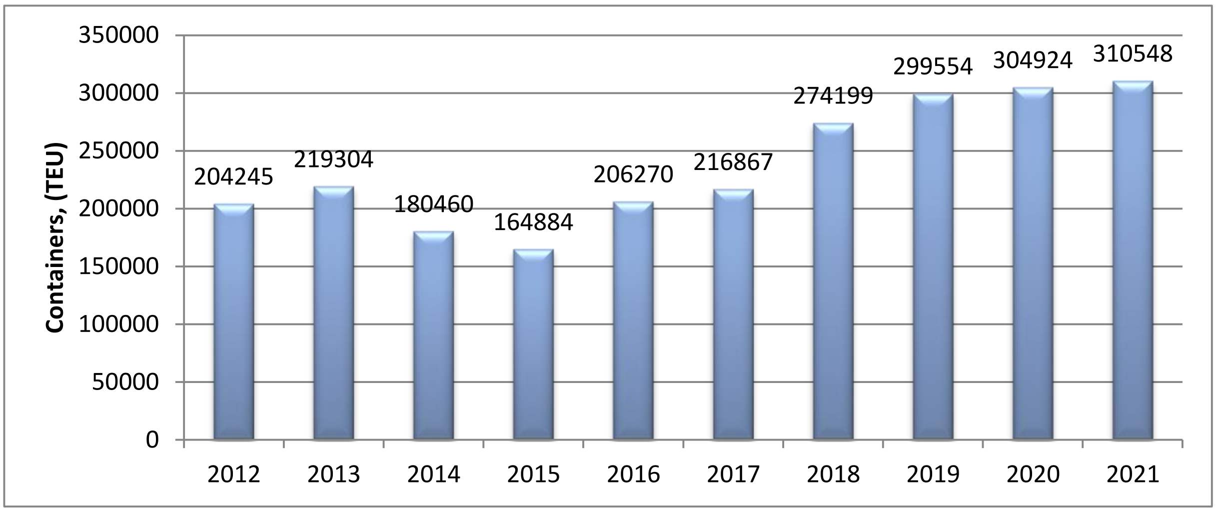

Figure 2. Volumes of processing of export cargoes in containers in the Odessa seaport for 2012-2021
Source: authors

In this regard, it is advisable to formalize an improved technology of managing the work of the railway station with the port during container transportation in the form of an optimization mathematical model. The objective function of the model is proposed to be given as the sum of operational costs for the performance of operations for processing large-tonnage containers at the station, in the port and possible financial losses in the form:

DOI: http://dx.doi.org/10.46925//rdluz.39.22

$$E = \sum_{i=1}^{5} E_i^{st} + \sum_{i=1}^{2} E_i^{n} + R \rightarrow \min, \qquad (1)$$

where E_i^{st} are operating costs of the port station for container batch processing; E_i^{n} are operating costs of the seaport for the formation of a container consignment for shipment; R is risk of financial losses.

The risk of financial losses should be understood as the actual losses of the railway in the process of transportation, processing and storage of goods, the costs of compensation for these losses and their consequences. A correct assessment of the actual value of the risk allows you to objectively determine the amount of possible losses.

Therefore, the last component of the objective function (1) reflects the possible risk of losses of the railway station and the port due to the occurrence of risky events that threaten the stable and safe operation of railway transport in the conditions of martial law. The latter include the human factor (R1), damage to vehicles (R2), blocking of seaports (R3), destruction of infrastructure (R4), power outages (R5).

Thus, for the best reflection of the level of financial risk, it is proposed to use the distribution density function associated with the normal distribution law. Then the definition of possible risk can be given in the following form:

$$R = \frac{C_{risk} \cdot q}{K \cdot \sigma\sqrt{2\pi}} \int_{t_{\min}}^{t_{\max}} t_{risk} \cdot e^{-\frac{1}{2}\left(\frac{t_{risk} - \overline{t_{risk}}}{\sigma}\right)^2} dt_{risk} \qquad (2)$$

where C_{risk} – costs from the implementation of risk events; t_{risk} – the delay time of large-tonnage containers due to the occurrence of risk events; K – the total number of containers arriving at the port station for a certain period.

Taking into account the above research, the final target function of the model of the improved technology for managing the work of a railway station with a port during container transportation under the relevant restrictions is as follows:

DOI: http://dx.doi.org/10.46925//rdluz.39.22

$$E(q)=\frac{e_{insp}}{q}+q\left(\frac{\alpha}{2}+(1-\alpha)\right)e_d\left(t_w^{dis}+t_d+t_w^{del}\right)+e_{sh}t^{dis}+$$
$$+\frac{e_s q}{\lambda}+q\left(\frac{\alpha}{2}+(1-\alpha)\right)e_{sh}\left(t_f^{cl}+t_{pl}^{ass}\right)+$$
$$+q\left(\frac{\alpha}{2}+(1-\alpha)\right)e_d\left(t_w^{co}+\frac{P_l}{ZQ_{op}}+t_w^{cl}\right)+ \qquad (3)$$
$$+\frac{C_{risk}\cdot q}{K\cdot\sigma\sqrt{2\pi}}\int_{t_{\min}}^{t_{\max}} t_{risk}\cdot e^{-\frac{1}{2}\left(\frac{t_{risk}-\overline{t_{risk}}}{\sigma}\right)^2}dt_{risk}\rightarrow \min,$$

where q is the batch of containers intended for loading on a ship of many containers; e_{insp} is the cost of commercial, technical and customs inspections; α – the proportion of containers 20 feet long of the total number of containers in the batch; it can be assumed that one platform with a length of 14.62 m is fed under the load of two containers 20 feet long or one - 40 feet long. Therefore, the number of cars can be determined by the formula:

$$N=q\left(\frac{\alpha}{2}+(1-\alpha)\right); \qquad (4)$$

e_d is the cost of wagon hours of downtime; t_w^{dis} – the time to wait for the disbandment of the train at the port station; e_{sh} – cost of locomotive-hours of shunting work; t_d – downtime of the wagon in the process of disbandment; e_s is the cost of saving one container when accumulating on a container batch; λ – intensity of arrival of containers to the port; t_w^{del} is the waiting time for the wagon to be delivered to the port berths due to the occupation of technical means; t_f^{cl} is the time for feeding and cleaning the wagon from the port berths; t_{pl}^{ass} is the time for placement-assembly of the wagon; t_w^{co}, t_w^{cl} – duration of waiting for cargo operations and waiting for cleaning of the wagon after cargo operations in connection with the employment of technical means and port workers respectively; P_l is the average loading of the wagon in containers; Z is the number of units of loading and unloading equipment; Q_{op} is the operational productivity of one unit of equipment.

DOI: http://dx.doi.org/10.46925//rdluz.39.22

The first appendix of the target function contains the costs of the port station on the arrival of wagons at the station, namely the performance of technical, commercial and customs inspections. The second appendix shows the station costs for waiting for the disbandment of the train, the downtime of wagons in the process of disbandment and the costs associated with waiting for the supply of wagons to the port berths. The third term of the function reflects the costs of the station for the disbandment of the composition, the fourth - for the preservation of containers when accumulating on the container batch. The costs of the port station for the supply and removal of wagons from the port berths and their placement and collection are taken into account in the fifth appendix.

Port costs include the sixth appendix to the target function, which includes costs related to waiting for cargo operations, unloading containers directly to the ship or to port berths and waiting for wagons to be cleaned after cargo operations.

The last addition is the possible risk of financial losses.

The condition of conformity of intensity of receipt of containers to processing capacity of a cargo front can be written down as:

$$\lambda \le Q_{fr}, \tag{5}$$

where Q_{fr} is processing capacity of the cargo front.

Restriction (6) determines the condition for fulfilling the restriction on the length of the cargo front:

$$q\left(\frac{\alpha}{2}+(1-\alpha)\right)l_{pl} \le l_{fr}, \tag{6}$$

where l_{pl} is the platform length; l_{fr} is the length of the cargo front.

Restriction (10) states that the total residence time of wagons with containers at the port station t_{tot} should not exceed the standard t_{st}:

$$t_{tot} \le t_{st}. \tag{7}$$

DOI: http://dx.doi.org/10.46925//rdluz.39.22

Given the relevant constraints, it is possible to determine the optimal batch size of large-tonnage containers 20 and 40 feet long, designed to be loaded onto a ship while minimizing operating costs.

The modeling made it possible to determine the improved technology of the interaction of the station and the port with the attention of the financial risk with constantly changing volumes of work. A graphical view of the simulation of this technology is shown in Figure 2.

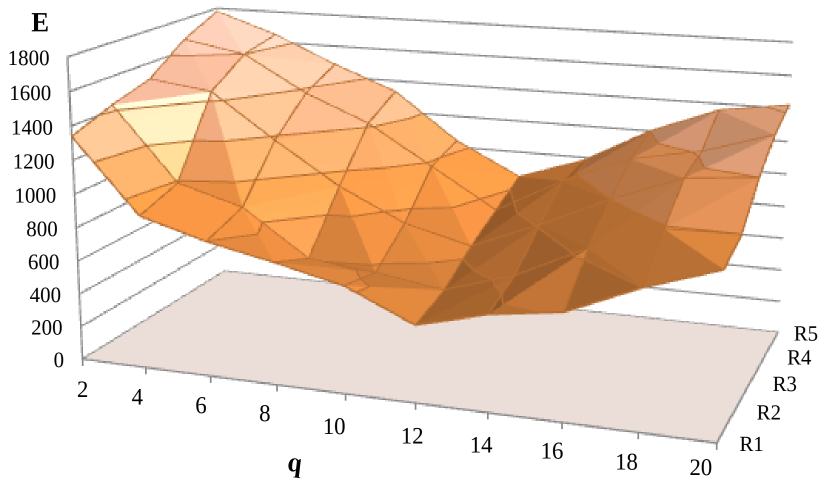

Figure 2. Dependence of financial losses on the size of the optimal batch of containers and the type of risk events
Compiled by the authors

The determined approach to finding optimal solutions for managing the work of the railway station with the port is the basis of the formation of a decision-making support system for operational personnel (maneuver dispatcher on duty at the station). A significant achievement of this study is the creation of a model of the improved technology for managing the work of a railway station with a port during container transportation.

An exceptional feature of the proposed model, in contrast to the works analyzed in the first section of this article, is the consideration of the possible risk of station and port losses due to the occurrence of risky events that threaten the stable and safe operation of railway transport under martial law. Power outages, destruction of infrastructure, blocking

DOI: http://dx.doi.org/10.46925//rdluz.39.22

of seaports, damage to vehicles and the human factor are proposed to be among the risk events. Taking into account such parameters in the mathematical model makes it possible to estimate the losses and damages that may occur during transportation, when performing technological operations with containers, as well as during their storage.

Conclusions

Conducted studies of the technological process management technology of the railway station in interaction with the port showed that the efficiency of their work determines the coherence of all links of the production process of transport enterprises as a whole. An important component of the interaction of rail and sea transport is the organization of the process of cargo transportation in containers. It has been established that today there is a tendency to increase the volume of export cargo processing in large-tonnage containers 20 and 40 feet long.

Under such conditions, a modern model for managing the work of the railway station with the port was developed to optimize the operational management process in order to minimize both operating costs and financial losses directly related to their operational activities. The concept of risk was used to model financial losses associated with the possibility of unwanted events.

The proposed improved technology for managing the work of the railway station and the port in the organization of container transportation based on a mathematical model in the form of the sum of the operating costs of the station, the port and the risk of financial losses is the basis for the formation of a decision support system for operational personnel (maneuver dispatcher on duty at the station). At the same time, the risks of station and port losses due to the occurrence of risky events that threaten the stable and safe operation of railway transport in the conditions of martial law were taken into account. To determine the risk of financial losses in the process of interaction between the railway station and the port, a model using the density function of the normal distribution law was proposed.

References

Andrić, J., Wang, J., Zhong, R. (2019). Identifying the Critical Risks in Railway Projects Based on Fuzzy and Sensitivity Analysis: A Case Study of Belt and Road Projects. Sustainability 11(5), 1-18 DOI: http://dx.doi.org/10.3390/su11051302

Baulina, H., Bohomazova, H. (2020). Formalization of the technology of the port station when interacting with the port. Development of Education, Science and Business: Results 2020: abstracts of the International Scientific and Practical Internet Conference, Dnipro, December 3-4, 1, 131-132

Baulina, H., Bohomazova, H., Prodashchuk, S. (2022). Forming a rational technology for service cargo points at railway connecting lines of industrial enterprises. Revista de la Universidad del Zulia 13(36), 357-372 DOI: http://dx.doi.org/10.46925//rdluz.36.23.

Bulgakova, J. (2016). Decision making on cargo-flows management in integrated production and transportation system. Transport problems 11/4, 83–94. DOI: http://dx.doi.org/10.20858/tp.2016.11.4.8

Butko, T., Vergeles, V. (2016). Improving the process of sypplying of port railway node with empty railcars. Zbirnyk naukovykh prats Ukrainskogo derzhavnohogo universytetu zaliznychnoho transportu, 163, 57-66.

Butko, T., Kostiennikov, O., Parkhomenko, L., Prohorov, V., Bogomazova, G. (2019). Formation of an automated technology of cargo transportation control on the direction. Eastern-European journal of enterprise technologies. Vol. 1, № 3 (97), 6–13. DOI: http://dx.doi.org/10.15587/1729-4061.2019.156098

Chislov, O., Bogachev, T., Kravets, A., Bogachev, V., Zadorozhniy, V., Egorova, I. (2020). Time Parameters Optimization of the Export Grain Traffic in the Port Railway Transport Technology System. In: Sierpiński G. (eds) Smart and Green Solutions for Transport Systems. TSTP 2019. Advances in Intelligent Systems and Computing 1091. Springer, Cham DOI: https://doi.org/10.1007/978-3-030-35543-2_11

Guo, R. Guo, J., Xie, G. (2016). Optimizing model of a railroad yard's operations plan based on production scheduling theory. Computers in Railways XV: WIT Transactions on The Built Environment, WIT Press. Vol. 162, 79–90. DOI: https://doi.org/10.2495/CR160081

Hirata, E. (2017). Contestability of Container Liner Shipping Market in Alliance Era. The Asian Journal of Shipping and Logistics 33(1), 027-032 DOI: https://doi.org/10.1016/j.ajsl.2017.03.004.

Koyuncu, K., Tavacıoğlu, L. (2021). Forecasting Shanghai containerized freight index by using time series models. Marine Science and Technology Bulletin 10(4), 426-434 DOI: http://dx.doi.org/10.33714/masteb.1024663

Matsuda, T., Hirata, E., Kawasaki, T. (2021). Monopoly in the container shipping market: an econometric approach. Maritime Business Review. Emerald Publishing Limited, 2397-3757 DOI: DOI: https://doi.org/10.1108/MABR-12-2020-0071

Nagornyi, Ye., Orda, A. (2018). Reliability's estimation of intermodal container transportation in the supply chains. Komunalne hospodarstvo mist. 7 (146), 60-64 DOI: https://doi.org/10.33042/2522-1809-2018-7-146-60-64

Peng, Z., Wang, H., Wang, W., Jiang, Y. (2019). Intermodal transportation of full and empty containers in harbor-inland regions based on revenue management. European Transport Research Review, 11, 7 DOI: https://doi.org/10.1186/s12544-018-0342-4.

Sansyzbajevab, Z., Mezitisa, M. (2017). Simulation of the Interaction of Railway Station and Harbor Fjodors Mihailovsa. Procedia Computer Science 104, 222 – 226. DOI: https://doi.org/10.1016/j.procs.2017.01.117

Shelekhan, G., Prodashchuk, S. (2017). Improvement of the interaction process of marshalling yards and portside stations at the service of exporting traffic volumes. Zbirnyk naukovykh prats Ukrainskogo derzhavnohogo universytetu zaliznychnoho transportu, 168, 10-18.

Shibasaki, R., Kawasaki, T. (2021). International intermodal container shipping network in South Asia: modelling and policy simulations. International Journal of Shipping and Transport Logistics 13(1/2), 70–101 DOI: http://dx.doi.org/10.1504/IJSTL.2021.10035116.

Stažnik, A., Babić, D., Bajor, I. (2017). Identification and analysis of risks in transport chains. Journal of Applied Engineering Science 151, 61-70 DOI: http://dx.doi.org/10.5937/jaes15-12179

Zhao, J., Zhu, X., Wang, L. (2020). Study on Scheme of Outbound Railway Container Organization in Rail-Water Intermodal Transportation. Sustainability, 12, 1519. DOI: http://dx.doi.org/10.3390/su12041519