ТРАНСПОРТ

UDC 656.135.073.42:63
DOI https://doi.org/10.32838/2663-5941/2022.2/29

Gryshchuk O.K.
National Transport University

Petryk A.V.
National Transport University

Yerko Ya.V.
National Transport University

FEATURES OF CUSTOMS SERVICE OF FOREIGN TRADE CARGO FLOWS ON MOTOR TRANSPORT

The article analyzes in detail the features of customs and logistics services for import, export and transit cargo flows. The methodology is substantiated and the prospects for the formation of the infrastructure of transport networks are determined on the example of the functioning of international transport systems. Features of performance of technological and production processes on motor transport for existing and innovative technologies are considered. The peculiarities of logistics-oriented operations are analyzed, the tasks on resource provision of customs-logistics terminals in the existing production structures are systematized.

It is noted that the peculiarities of customs services for foreign trade and transit goods flows by road should take into account the specifics of the implementation of the provisions of the Customs Convention on the International Carriage of Goods. Therefore, in order to ensure the reliable transportation of consolidated import and export consignments of goods, it is necessary to adhere to the technology of customs formalities specified in the legislative documents during customs control. In addition, the peculiarities of the functioning of customs and logistics systems in road transport should take into account the customs clearance of goods and commercial vehicles.

Emphasis is placed on the fact that an important indicator of the perfection of the customs and logistics system is the generalized total costs of servicing foreign trade flows. For import and export cargo flows, this indicator comprehensively takes into account both the infrastructure and the legal mechanism for customs formalities to optimize economic performance in customs and logistics systems.

By conducting multivariate calculations using the basic provisions of the theory of queuing in the work determined the optimal number of vehicles in the customs and logistics system. In the process of conducting a study of the infrastructural support of foreign trade flows in the system of servicing imported goods, new results were obtained for the formation of appropriate infrastructure in transport and logistics terminals.

Key words: *transport and technological processes, customs and logistics systems, technological characteristics, transport and logistics terminals, infrastructure.*

Formulation of the problem. During the period of Ukraine's independence, the legislature has significantly improved the regulatory and legal documentation on customs issues, which indicates a significant attention of the state to these public relations. To some extent, this situation is explained by the fact that qualitative changes have taken place in Ukraine's international economic relations, the volume of export-import operations with goods moving across the customs border of Ukraine has increased. The growth of the movement of goods is carried out using different modes of transport (water, air, rail, road).

The movements of goods across the customs border of Ukraine by these modes of transport have their own characteristics that affect the application of the bodies of revenues and fees of the relevant customs procedures. State legislation defines an exhaustive list of relevant operations as a set of customs formalities and the procedure for their implementation, in accordance with the purpose of movement of goods in international traffic [1, p. 21]. The term «customs

formalities» is interpreted as a set of actions to be performed by relevant persons and customs authorities, as well as an automated system of customs clearance in order to comply with the legislation of Ukraine on customs matters.

A systematic approach to the study of the peculiarities of customs services for imported goods in road transport involves analyzing the specifics of the implementation of the provisions of the Customs Convention on International Carriage of Goods using the Book of International Road Transport. Numerical characteristics of transport systems largely depend on the results of customs formalities for foreign trade flows [2, p. 178]. Thus, the optimization of structural parameters in transport and technological systems of international orientation requires scientific analysis of customs control and customs clearance of commercial vehicles that move goods across the customs border of Ukraine.

Analysis of recent research and publications. In the literature the technology and sequence of customs formalities on motor transport are studied in detail [3, p. 365]. The content of such procedures in each case is determined by the purpose of movement (customs regime), means of service (mode of transport), methods of cargo and characteristics of transport and technological systems (contract of carriage) [4, p. 82]. However, the conclusion that the internal structure of customs formalities in relation to motor vehicles is quite close to the intertwining of stages and stages, indicates the closeness of the terms «customs formality» and «customs procedure».

The approved regulations contain fundamental provisions governing the procedure for customs formalities related to customs control and customs clearance of motor vehicles, goods (cargo) moving across the customs border of Ukraine. The sequence of actions of authorized officials during customs control and customs clearance of motor vehicles and goods is determined by a standard technological scheme, as the basis of the legal mechanism for customs formalities to ensure international road transport [5, p. 81].

As the complexity of customs and logistics systems becomes more responsible and the assessment of the efficiency of their work [6, p. 332]. Indicators of cost-effectiveness of individual operations for many structures are insufficient, because, focusing only on the transportation process, they do not take into account the impact on the final result of their production activities of the existing infrastructure [7, p. 11].

Therefore, the indicators of efficiency of customs and logistics support of the integrated transport and technological system should be understood as reasonable numerical parameters that assess the degree of its adaptability to the tasks set before it [8, p. 48]. Such efficiency indicators should be generalized characteristics of the infrastructure of transport systems [9, p. 409].

Presenting main material. Customs formalities carried out during customs control and customs clearance of goods and commercial vehicles, which move goods across the customs border of Ukraine, have a unified nature [10, p. 67]. In this case, the subjects of taxation do not depend on the country of registration or the owner of the vehicle, the country from which the vehicle arrived, or the country to which it goes, except as provided by international treaties of Ukraine [11, p. 225].

The specificity of international road transport is the implementation of checkpoints open to road traffic, control of international road transport, namely:

– control of the availability of permits for transportation;

– dimensional and weight control of vehicles;

– control over the observance by carriers of the rules of transportation of dangerous goods;

– control of payment (accrual) by non-resident carriers of payments for travel on highways of Ukraine;

– control of payment of fines by carriers or compliance with instructions of control bodies;

– keeping records of motor vehicles engaged in international transportation of passengers and goods by road.

Customs authorities perform customs formalities in customs control zones established in accordance with the provisions of the Customs Code. And in order to speed up the completion of customs formalities when moving commercial vehicles across the customs border of Ukraine, employees of water, air, road and rail transport assist customs officials in the performance of their duties. And the legal mechanism for international road transport consists of international agreements (multilateral, regional, bilateral) and national legislation [12, p. 198]. Legal relations with the movement of motor vehicles across the customs border of Ukraine are regulated not only by international agreements of Ukraine, but also by state national legislation (Fig. 1).

Based on the results of the analysis of the implementation of the provisions of the Customs Convention on the International Carriage of Goods using the TIR Carnet, it can be concluded that the customs formality – border control consists of the following actions:

- submission of documents by the carrier (driver) at the checkpoint;

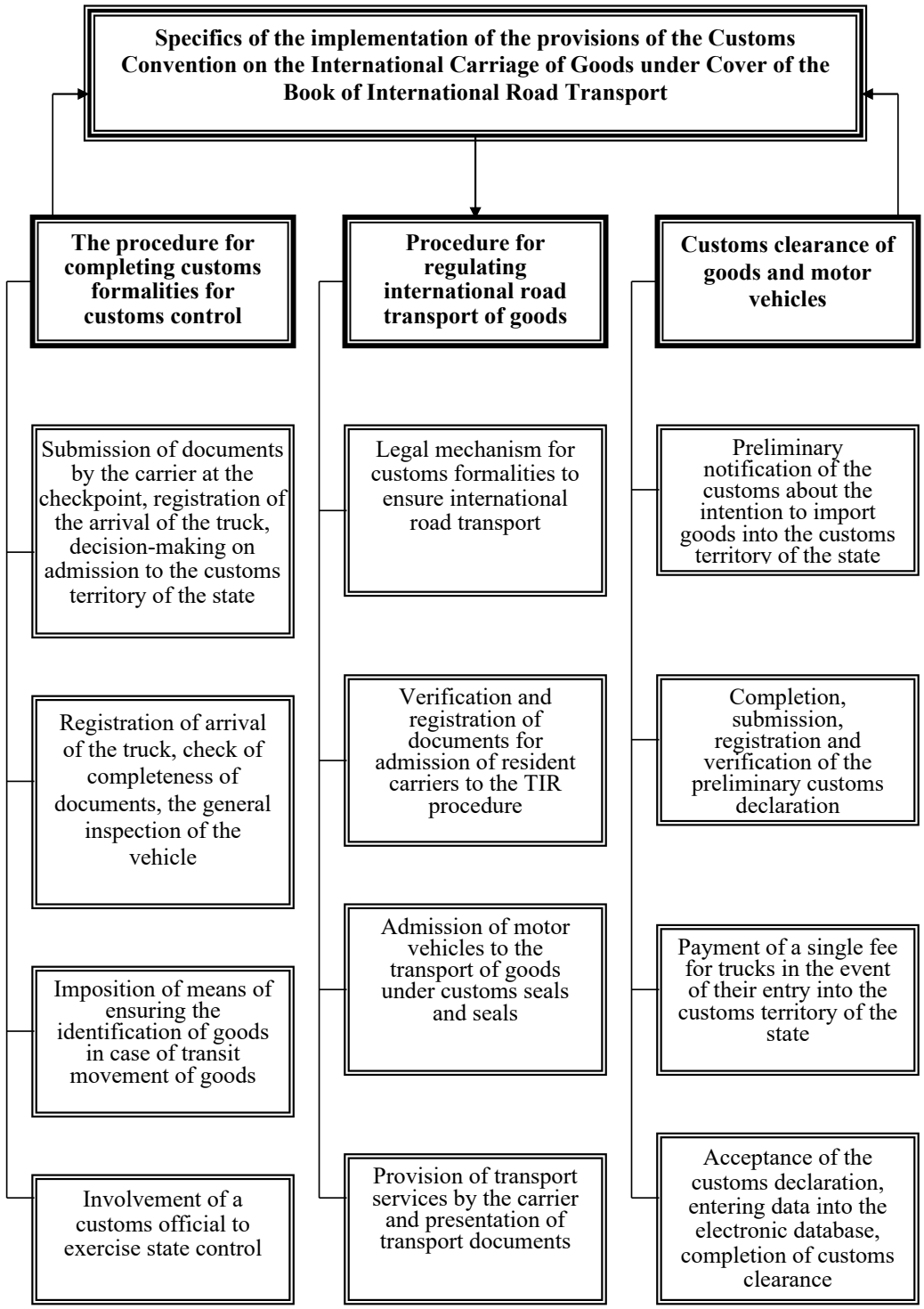

Fig. 1. Features of customs service of imported cargo flows on motor transport

- registration of the arrival of the truck;
- checking the completeness of documents;
- general inspection of the truck;
- making a decision on admission or refusal of admission to the customs territory of Ukraine.

The purpose of customs clearance is to ensure compliance with the procedure established by the legislation of Ukraine for the movement of goods, commercial vehicles across the customs border, as well as statistical accounting of imports into the customs territory of the state, export and transit through its territory.

Customs control of goods and vehicles and customs clearance is carried out in accordance with standard technological issues in customs matters. In order to increase the effectiveness of the implementation of the provisions of the Customs Convention

on the International Carriage of Goods, the customs authorities cooperate with participants in foreign economic activity.

And in order to speed up the completion of customs formalities during the transportation of goods in international traffic, enterprises and economic entities of various modes of transport assist customs structures in the performance of their official duties and create appropriate working conditions for them.

An important indicator of the perfection of the customs and logistics structure is the total cost of servicing foreign trade flows. This indicator comprehensively takes into account both the conditions of customs formalities for customs control and the organization of customs clearance of goods and motor vehicles, which directly affects the overall level of costs. The nature of changes in the indicators of customs and logistics services determines the main directions in the search for improving the infrastructure of the transport system.

The presence of a significant number of random influencing factors on the resulting economic indicators of customs and logistics services provides good reasons for creating mathematical models using the basic theoretical principles of queuing systems. At the same time, when servicing vehicles in the customs terminal, it is convenient to describe the presentation of cars for loading by the simplest flow, which is characterized by stationary and lack of aftereffects. This technology of transport processes is considered on the example of the operation of a multi-channel dynamic system with a finite number of degrees of freedom. The input flow λ of requirements is the arrival of empty cars for loading at the customs terminal for service mechanisms. The intensity μ of the service flow of requirements by each channel is determined by the average number of loaded vehicles per unit time. The process of loading consolidated cargo in the terminal in the car is performed by service mechanisms according to the principle of non-priority service discipline FCFS (First Come First Served): «first come – first served». In accordance with these conditions, the car is at the end of the service queue, if all the mechanisms of the terminal are occupied and immediately begins to be serviced in the presence of at least one free channel.

The main task of the study of queuing systems is to determine the probabilities of states p_k that at time t the system will be in state k. In the steady state to determine the value of p_k there are relations

$$\left[(n-k)\lambda + k\mu\right] p_k = (n-k+1)\lambda p_{k-1} + (k+1)\mu p_{k+1},$$
$$\text{at } 1 \le k \le m; \qquad (1)$$

$$\left[(n-k)\lambda + m\mu\right] p_k = (n-k+1)\lambda p_{k-1} + m\mu p_{k+1},$$
$$\text{at } m+1 \le k \le n \qquad (2)$$

where n – the total number of cars in the system;
m – number of service mechanisms.

The maximum probabilities of the system in the k state are determined depending on the probability p_0 of the zero situations (no applications)

$$p_k = p_{k-1}\left(\frac{\rho}{k}\right)(n-k-1)\,p_0, \text{ where } 1 \le k \le m \quad (3)$$

$$p_k = p_{k-1}\left(\frac{\rho}{m}\right)(n-k-1)\,p_0, \text{ where } m+1 \le k \le n \quad (4)$$

$$p_0 = \left[\sum_{k=0}^{m} \frac{n!}{k!(n-k)!} p^k + \sum_{k=m+1}^{n} \frac{n!}{m!(n-m)!m}\right]^{-1} \quad (5)$$

Rational management of material resources in customs and logistics systems is based on the principle that one of the tasks of the customs cargo terminal is to minimize production costs by rationally choosing the infrastructure of the facility. From this point of view, efficiency means the ability of the system to maintain an equilibrium state, which is to maintain certain parameters near a constant level.

The optimal way to achieve the minimum cost under the operational management of two types of costs x_1, x_2 is determined by the geometric location of the points for which these costs are constant. The path of long-term development of the transport system shows the nature of changes in the cost mechanism.

In the theory of optimal management of material resources in general, such transport systems are considered, the behavior of which can be influenced or controlled by changing the control parameters. The latter are selected taking into account the restrictions specific to a certain class of systems. Therefore, the purpose of creating mathematical models based on the theory of optimal control is to develop methods for selecting numerical values of input parameters, provided that the optimum is achieved by a certain functional.

The tasks of this direction arise not only in the study of modern customs and logistics systems, which contain complex processes of cargo movement, and therefore not yet developed in detail, but also in the study of issues related to assessing the end results of transport systems in the international direction.

In mathematical models, the influence of these factors is characterized by numerical values of the time of rotation of the car on the route, the intensity of the requirements and the duration of their maintenance. In addition, in order to determine the economic performance of transport systems, the

developed mathematical models should take into account the numerical values of the cost of transport and loading and unloading operations and the costs associated with unproductive downtime of individual elements.

With such a question in the objective function of optimizing the structure of the customs and logistics system, the number of cars n is considered as a control variable. Its optimal value of n_{opt} is determined by minimizing the cost function $F(n)$ per 1 ton of processed and transported goods

$$F(n) = \frac{P_k S_k}{\mu q} + S_m + \frac{1}{K_z \mu q}\left(C_k K_n + C_a A_n\right) \qquad (6)$$

where P_k – hourly productivity of the service post at the customs terminal, ton/hour;

S_k – hourly costs for the operation of the loading station in the terminal, €/hour;

μ – the intensity of service at the customs post cars with a capacity q, cars/hour;

K_z – the average number of working service posts;

S_m – cost of transportation of 1 ton of consolidated consignment of export-import cargoes by distance, €/ton;

K_n – the average number of non-working service posts waiting for cars;

A_n – the average number of cars in the expected maintenance;

$C_к$, C_a – downtime costs for service stations and vehicles, respectively, €/hour.

Using the general solution of the system of equations (3 – 5) for the process of transport service in a closed system, the numerical value of $K_z = A_z$ is defined as

$$K_z = \sum_{k=1}^{m-1} k p_k + m \sum_{k=m}^{n} p_k = \sum_{k=1}^{m-1} k p_k + m\left(1 - \sum_{k=0}^{m-1} p_k\right) \qquad (7)$$

The number of posts in the terminal that are waiting for cars to be serviced by K_n, using mathematical dependencies (6, 7) is set as

$$K_n = \sum_{k=0}^{m-1} (m-k) p_k \qquad (8)$$

The average required number of cars that are in line for service is

$$A_n = \sum_{k=m}^{n} (k-m) p_k \qquad (9)$$

Expenses related to downtime of S_k service stations and C_a cars should be interpreted as fixed costs in determining the cost of transportation with additional charges (protection of temporary parking, food for drivers, cash for business trips, etc.).

That is why the task of analyzing the effectiveness of the transport and technological system in relation to the end result is to determine the existing opportunities for this system to achieve the goal in terms of uncertainty of environmental parameters.

In the study of reliability and cost-effectiveness of customs and logistics systems in the process of customs service of foreign trade flows there are conditions characterized by various random factors: changes in demand for transport services, the possibility of attracting additional vehicles, changing the numerical value of operating costs. As an example of optimizing the structure of customs and logistics systems, the determination of the total costs of servicing the imported cargo flow of packaged goods from the condition of delivery of wholesale consignments from the customs transport terminal to consumers is considered. If loading works are performed at three ($m = 3$) posts of service and delivery of these goods at an average distance of $l = 30$ km, the optimal value of vehicles with a capacity of $q = 10$ tons is $n = 26$ units (Fig. 2).

The increase in total costs in the absence of a sufficient number of vehicles is explained as an increase in K_n of the average number of non-working service stations waiting for cars and, accordingly, a decrease in K_z working. And since the product of $C_k K_n$ is in the numerator, and the product of $K_z \mu$ is in the denominator of the third component of the mathematical expression (6), the resulting indicator $F(n)$ increases significantly.

The trend of increasing total costs with an excessive number of vehicles in the customs and logistics system indicates the emergence of forced downtime of cars waiting for service. In mathematical expression (6), the change in $F(n)$ is explained by the effect of increasing the average number of A_n cars in the expected maintenance. Moreover, under $n > n_{opt}$, the growth rate of the $C_a A_n$ component is significantly ahead of the rate of decrease of the $C_k K_n$ component in the system.

The randomness of transport technology processes is especially common in long-term planning and forecasting of numerical values of customs and logistics systems, because it is impossible to accurately determine the optimization costs associated with the operation of transport systems, standards and trends for unforeseen reasons. That is why the use of mathematical modeling in these cases makes it possible to respond quickly to changes in influencing factors.

Using the above theoretical prerequisites to optimize the production structure of customs logistics systems, it became possible to analyze the impact of

hourly productivity P_k service post at the customs terminal on the resulting indicator *F(n)* of total costs (Table 1).

The results of comparing the total costs *F(n)* for the three variants of the numerical value of the indicator P_k shows that with increasing productivity of service stations, the optimal cost value tends to decrease (from *F(n)* = 9,68 €/ton for P_k = 30 t/hour to *F(n)* = 9,408 €/ton for P_k = 50 ton/hour). In addition, the current cost-effectiveness of customs and logistics services is also significantly improved with increasing productivity of service stations. This situation is explained by the fact that with increasing P_k increases the numerical value of the optimal number of n_{opt} vehicles, and accordingly increases the average number of vehicles per service post.

These circumstances also explain the «sensitivity» of customs and logistics structures to changes in the numerical value of cars in the system. For example, the absence of six cars in the system increases the total loss *F(n)* from 5,1% for P_k = 30 ton/hour to 1,4% for P_k = 50 ton/hour. The same trend is observed with an excessive number of cars. Thus, the presence of 12 «additional» vehicles in the system causes an increase

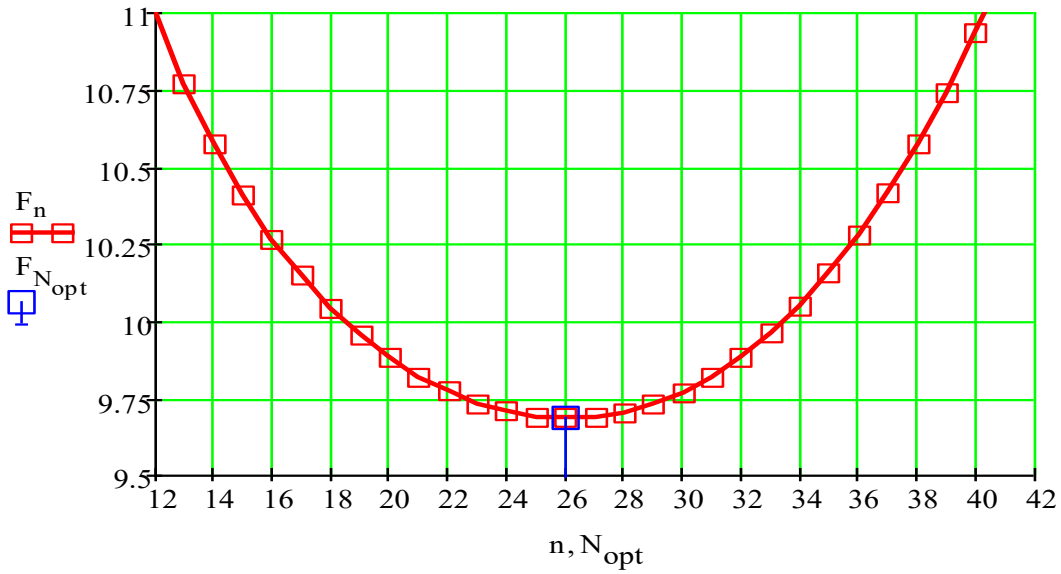

Fig. 2. Determining the optimal number of vehicles when servicing the imported batch of packaged construction cargo at the customs terminal

Table 1

Change in the total costs of the customs and logistics system for the service of goods in the «import» mode, subject to different productivity of service stations

Number of vehicles in the system	Hourly productivity of the service post at the customs terminal, ton/hour					
	P_k = 30 ton/hour		P_k = 40 ton/hour		P_k = 50 ton/hour	
	F(n), €/ton	ΔF(n), €/ton	F(n), €/ton	ΔF(n), €/ton	F(n), €/ton	ΔF(n), €/ton
n_{opt}	9,68	–	9,51	–	9,40	–
n_{opt} – 3	9,74	0,06	9,53	0,02	9,42	0,02
n_{opt} – 6	9,90	0,22	9,59	0,08	9,46	0,06
n_{opt} – 9	10,17	0,49	9,71	0,20	9,53	0,13
n_{opt} – 12	10,60	0,92	9,89	0,38	9,63	0,23
n_{opt} – 15	11,29	1,61	10,14	0,63	9,77	0,37
n_{opt} + 3	9,73	0,05	9,54	0,03	9,41	0,01
n_{opt} + 6	9,88	0,20	9,63	0,12	9,46	0,06
n_{opt} + 9	10,16	0,48	9,78	0,27	9,54	0,14
n_{opt} + 12	10,57	0,89	10,01	0,50	9,66	0,26
n_{opt} + 15	11,14	1,46	10,32	0,81	9,84	0,44

in $F(n)$ from 9,1% for P_k = 30 ton/hour to 2,8% in the case of P_k = 50 ton/hour. In addition, with high productivity P_k of key elements of the customs and logistics system increases the stability of its work, as evidenced by the rate of change of total costs $\Delta F(n) = F(n) - F(n_{opt})$ in the transport and technological cycle.

Conclusions. In the process of conducting a study of customs and logistics support of foreign trade flows in the system of servicing imported goods, new results were obtained for the formation of appropriate infrastructure in customs terminals. By creating appropriate mathematical models in the work, the value of the optimal number of n_{opt} vehicles is calculated. On the basis of the main provisions of the theory of queuing the regularities of determining the resulting indicators of the functioning of production formations of international orientation are considered. It is established that with increasing productivity of service posts, the optimal values of total customs and logistics costs decrease. By conducting multivariate calculations, the regularity of the behavior of customs and logistics structures to changes in the numerical value of cars in the system is substantiated.

The study can be useful to improve the efficiency of customs and logistics services for foreign trade flows in international production structures. However, when performing multivariate calculations, in addition to the impact of resource provision for foreign trade, the peculiarities of servicing packaged goods by road and the performance characteristics of structural elements of the customs and logistics system must be taken into account.

References:

1. Apfelstädt A., Dashkovskiy S., Nieberding B. Modeling, Optimization and Solving Strategies for Matching Problems in Cooperative Full Truckload Networks, *IFAC-Papers On Line.* 2016. Vol. 49 (2). P. 18-23.

2. Danchuk V., Bakulich O., Svatko V. Identifying optimal location and necessary quantity of warehouses in logistic system using a radiation therapy method, *Transport.* 2019. Vol. 34, № 2. P. 175-186.

3. Taji T., Tanigawa S-I., Kamiyama N., Katoh N., Takizawa A. Finding an optimal location of line facility using evolutionary algorithm and integer program, *Journal of Computational Science and Technology.* 2008. № 2(3). P. 362-370.

4. Beloglazov A., Banerjee D., Hartman A., Buyya R. Improving Productivity in Design and Development of Information Technology Service Delivery Simulation Models, *Journal of Service Research.* 2014. Vol. 18 (1). P. 75-89

5. Prokudin, G.; Remekh, K.; Maidanyk, K. The efficiency of the runsystem application in international freight transportation, *Politechnika Rzeszowska.* 2017. № 10. P 79-86.

6. Sonmez A.D., Lim G.J. A decomposition approach for facility location and relocation problem with uncertain number of future facilities, *European Journal of Operational Research.* 2012. Vol. 218, № 2. P. 327-338.

7. Shin S., Roh, H.-S., Hur, S. Characteristics Analysis of Freight Mode Choice Model According to the Introduction of a New Freight Transport System, *Sustainability.* 2019. Vol. 11(4), 1209 p.

8. Vorkut T., Volynets L., Bilonog O., Sopotsko O., Levchenko I. The model to optimize deliveries of perishable food products in supply chains, *Eastern-European Journal of Enterprise Technologies.* 2019, № 5. P. 43-50.

9. Crainic T., Perboli G., Rosano M. Simulation of intermodal freight transportation systems: a taxonomy, *European Journal of Operational Research.* 2018. Vol. 270, № 2, P 401-418.

10. Kulbovskyi I., Bakalinsky O., Sorochynska O., Kharuta V., Holub H., Skok P. Implementation of innovative technology for evaluating high-speed rail passenger transportation, *EUREKA: Physics and Engineering.* 2019, № 6. P. 63-72.

11. Ritzinger U., Puchinger J., Hartl R. A survey on dynamic and stochastic vehicle routing problems, *International Journal of Production Research.* 2015. Vol. 54, № 1. P. 215-231.

12. Melo, M.T., Nickel, S., Saldanha da Gama, F. Dynamic multi-commodity capacitated facility location: a mathematical modelling framework for strategic supply chain planning, *Computers & Operations Research*. 2006. Vol. 33(1). P. 181-208.

Грищук О.К., Петрик А.В., Єрко Я.В. ОСОБЛИВОСТІ МИТНОГО ОБСЛУГОВУВАННЯ ЗОВНІШНЬОТОРГОВЕЛЬНИХ ВАНТАЖОПОТОКІВ НА АВТОМОБІЛЬНОМУ ТРАНСПОРТІ

У статті детально проаналізовано особливості митно-логістичного обслуговування імпортних, експортних та транзитних вантажопотоків. Обґрунтовано методологію та визначено перспективи формування інфраструктури транспортних мереж на прикладі функціонування транспортних систем міжнародного спрямування. Розглянуто особливості виконання технологічно-виробничих процесів на автомобільному транспорті для існуючих та інноваційних технологій. Проаналізовано особливості

проведення логістико-орієнтованих операцій, систематизовані задачі щодо ресурсного забезпечення митно-логістичних терміналів в існуючих виробничих структурах.

Зазначено, що особливості митного обслуговування зовнішньоторговельних та транзитних товаропотоків на автомобільному транспорті повинні враховувати специфіку реалізації положень Митної конвенції про міжнародне перевезення вантажів. Тому для забезпечення надійного перевезення консолідованих імпортних та експортних партій товарів необхідно дотримуватись визначеної законодавчими документами технології виконання митних формальностей при здійсненні митного контролю. Крім того, особливості функціонування митно-логістичних систем на автомобільному транспорті повинні враховувати проведення митного оформлення товарів і транспортних засобів комерційного призначення.

Акцентовано увагу на тому, що важливим показником досконалості митно-логістичної системи є узагальнені сумарні витрати на обслуговування зовнішньоторговельних вантажопотоків. Для імпортних та експортних вантажопотоків зазначений показник комплексно враховує як інфраструктурне забезпечення так і правовий механізм виконання митних формальностей для оптимізації економічних показників в митно-логістичних системах.

Шляхом проведення багатоваріантних розрахунків з використанням основних положень теорії масового обслуговування в роботі визначена оптимальна кількість транспортних засобів в митно-логістичній системі. В процесі проведення дослідження інфраструктурного забезпечення зовнішньоторговельних вантажопотоків в системі обслуговування імпортних товарів отримано нові результати для формування відповідної інфраструктури в транспортно-логістичних терміналах.

Ключові слова: *транспортно-технологічні процеси, митно-логістичні системи, технологічні характеристики, транспортно-логістичні термінали, інфраструктурне забезпечення.*