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DEVELOPMENT OF TRANSPORT AND TECHNOLOGICAL PROCESS OPTIONS' CONCEPT FOR GOODS DELIVERY WITH PARTICIPATION OF MARITIME TRANSPORT

Об'єктом дослідження є транспортно-технологічний процес доставки вантажів за участю морського транспорту. Однією з причин неефективної доставки вантажів з використанням морського транспорту є відсутність теоретичної бази інтегрального розгляду транспортно-технологічного процесу доставки в рамках всієї системи доставки. Це відповідним чином впливає на практичну реалізацію доставки вантажів. Традиційний підхід передбачає розгляд транспортно-технологічного процесу в межах однієї з ділянок доставки та спирається на відповідну транспортно-технологічну систему. Сучасний транспортний ринок і технологічна база портових терміналів дозволяють варіювати та комбінувати транспортні технології на різних ділянках доставки вантажу. Це обумовлює відповідну багатоваріантність транспортно-технологічного процесу при інтегральному його розгляді. Такий підхід і з'явився ідейною основою даного дослідження.

Встановлено два рівні розгляду транспортно-технологічного процесу. Перший – це рівень окремих учасників процесу доставки вантажів (наприклад, портового терміналу, морського перевізника). Другий – рівень всієї системи доставки від пункту відправлення до місця переходу відповідальності для двох сторін зовнішньоторговельного контракту. Рівень розгляду транспортно-технологічного процесу обумовлює керованість цим процесом. При інтегральному його розгляді транспортно-технологічний процес виступає як об'єкт управління для організатора доставки/вантажовласника. Встановлено відповідність між транспортно-технологічними системами та транспортно-технологічним процесом доставки, згідно з яким останній в якості технологічної основи може використовувати комбінацію декількох транспортно-технологічних систем. Визначено основні варіанти транспортно-технологічного процесу доставки (на прикладі експорту) за участю морського транспорту шляхом варіювання різних транспортно-технологічних систем на різних ділянках доставки. Обґрунтовано межі варіювання транспортно-технологічним процесом доставки в залежності від базису поставки.

Результати даного дослідження дають можливість підвищення ефективності транспортного забезпечення зовнішньоторговельних контрактів за рахунок інтегрального розгляду різних технологій в рамках єдиної системи доставки. Подальший розвиток даних результатів орієнтовано на оптимізацію параметрів процесу доставки відповідно до заданого критерію та обмежуючих умов.

Ключові слова: *транспортно-технологічна система, доставка вантажів, морський транспорт, портовий термінал, морський перевізник, базис поставки.*

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1. Introduction

According to the generally accepted approach, the transport and technological process is a set of cargo movement operations that form the technical and technological subsystem of the cargo delivery system (in accordance with [1]). Transport and technological processes can be considered:

– at the level of individual subsystems of the cargo delivery system (for example, at the level of transport nodes – ports, customs terminals, at the level of a transport enterprise);

– integrated (that is, to cover the entire chain of operations related to the movement of goods within the framework of delivery from the point of departure to the destination).

The first approach is aimed at ensuring efficiency for a particular delivery participant, the second – at ensuring delivery efficiency for the organizer or cargo owner. At the same time, the ideology of coordinating the operations of the transport and technological process in modern conditions is the logistic approach [2], where transport plays the role of a providing element of logistic systems [3, 4] of various levels (sales, supply or internal production).

A clear identification of the structure of the various options of the transport and technological process is the first step to optimize its parameters taking into account the given requirements. Given the importance

of the participation of sea transport in the processes of cargo delivery and the real demands of the practice of the transport business, the study of the structure of options for the transport and technological process of cargo delivery with the participation of sea transport as part of an integrated review is relevant.

2. The object of research and its technological audit

The object of research is the transport and technological process of cargo delivery with the participation of sea transport. This process is considered integrally, that is, within the entire delivery from the point of departure to the destination. The transport and technological process is a sequence of operations for the physical movement of cargo and is a technical and technological component of the cargo delivery system [5]. The modern transport market and the technological base of port terminals make it possible to vary transport technologies at various sections of cargo delivery, which leads to the corresponding multivariance of the transport and technological process.

One of the reasons for the ineffective delivery of goods using sea transport is the lack of a theoretical basis for an integrated review of the transport and technological delivery process involving sea transport, which accordingly affects the practical implementation of cargo delivery.

3. The aim and objectives of research

The aim of this research is development of a concept for the formation of options for the transport and technological process of cargo delivery with the participation of maritime transport, as an ideological basis for further research on optimization issues and ensuring the effectiveness of this process.

To achieve this aim it is necessary to perform the following objectives:

1. To identify the two-level nature of the transport and technological process of cargo delivery.

2. To determine the main options for the transport and technological process of cargo delivery involving sea transport and to establish their relationship with transport and technological systems.

3. To determine the boundaries of variation of the transport and technological process, depending on the transport conditions of the foreign trade contract.

4. Research of exiting solutions of the problem

A significant amount of research has been devoted to the problems of substantiating the option and optimizing the transport and technological process of cargo delivery.

The transport and technological system is the «environment» in which the corresponding transport and technological process takes place, that is, the implementation of these operations. In [1, 5], the concepts of «system» and «process» are characterized in various aspects related to delivery, and, in particular, it is established that the transport and technological process is a technological component of the process of cargo delivery. Depending on the specifics of the cargo, it can proceed in the corresponding transport and technological system or without it, if it is talk about goods for the transportation of which no enlargement means are used.

Questions of the transport and technological process at the level of transport nodes are considered in the works of many scientists. So, in [6], the coordination of production processes in seaports (terminals) is investigated. In [7, 8], the coordination of production processes is also studied, only in railway junctions. And in [9, 10], the coordination of production processes is studied, but already at the terminal level in the framework of international road transport.

The work of ships of various specializations within the framework of various transport and technological systems is considered in [11], where, in particular, among a wide range of tasks, the problems of substantiating the conditions of expediency of a ship entering a port and optimizing ship loading were solved.

Transport and technological processes of road transport are considered in [12, 13]. The works [14, 15] is devoted to an integrated consideration of transport and technological processes of cargo delivery. In particular, in [16], a variety of options of this process is considered using various combinations of automobile and railway transport and the corresponding customs complexes.

In [14, 17], the problems of the functioning of transport and technological systems are investigated, that is, a process view of the technological component of the cargo delivery system is implemented, and attention is paid to the uncertainty of this process.

It should be noted that the logistics system is a higher order system in relation to the cargo delivery system (according to [1]). Nevertheless, the formation of the optimal composition of the logistics system in individual situations can be considered comprehensively with the problem of its transport and technological support, and, in particular, in [18] this approach is implemented.

Thus, according to the results of the analysis of modern research on the organization of efficient transport and technological systems and related processes, the following conclusions can be drawn:

1) almost the majority of the work is focused on the automobile delivery of goods, a smaller number consider rail delivery and only a few works consider the transport and technological process of cargo delivery involving sea transport;

2) work related to the transport and technological component of cargo delivery by sea is aimed at ensuring the effectiveness of individual subsystems – ports, shipping companies, and to a greater extent focus on the processes of ships in the framework of these systems. That is, the tasks that are being considered are oriented towards shipowners and ensuring the efficiency of the ships performing the cargo service process.

The above justifies the prospects of considering the transport and technological process of cargo delivery with the participation of sea transport within the entire delivery process.

5. Methods of research

In this research, the methods of analysis and synthesis are used to solve all the problems posed. The correlation of transport-technological systems and the transport-technological process is carried out on the basis of the system

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methodology and methodology of transport processes and systems. The morphological method is used in the formation of the main options for the transport and technological process of cargo delivery involving sea transport.

6. Research results

The delivery of goods is carried out within the framework of the corresponding delivery systems, the technological «foundation» of which may be transport and technological systems [1–3], that is, a set of elements (operations), many of which form the process of moving cargo within the framework of a single technology. At the same time, the basis of transport and technological systems is the method of consolidation of goods, the most common of which is a universal sea container.

Thus, when considering the delivery of goods, two objects arise that can be studied both sequentially and comprehensively – this is the «transport-technological system» and «transport-technological process». At the same time, these objects are inextricably linked with higher order systems – the cargo delivery system and the cargo delivery process, respectively.

According to modern concepts, «delivery» includes not only operations directly related to the movement of goods (transport and technological component of delivery), but also many elements that are binders in the delivery processes. These elements organize or facilitate [1, 7] the implementation of the transport and technological process. First of all, this category includes freight forwarding services, which today are a kind of integrator for the delivery of goods.

The level of consideration of the transport and technological process determines the controllability of this process (Fig. 1): if the transport and technological process is considered at the level of, for example, port complex/terminal, then the processes inside this complex is the control object for the management system of this complex/terminal. In turn, if the transport and technological process of the entire delivery is considered, then it acts as a management object for the delivery organizer/cargo owner.

The transport and technological process is not only the order of operations, but, first of all, their nature/specificity in relation to the type of technology for transporting goods. The latter implies what the cargo represents from the transport and technological point of view – bulk, liquid or piece-loaded. It should be noted that modern sea transport is characterized by the fact that the same cargo can be transported in several ways, for example, as bulk (liquid, container-piece) or using enlargement tools (containers). Grain, vegetable oil and wood are typical representatives of these categories of goods, which for the last decade have been delivered both using containers and without them.

And in particular, today many specialized terminals of Ukrainian sea trade ports are rebuilding their technological base for the possibility of containerizing «non-containerized» traditional cargoes [19]. Thus, port container terminals provide containerization of almost any cargo (except, of course, oversized).

In this study, the transport and technological process is considered from the perspective of the cargo owner and, taking into account the weight of the export component in the structure of foreign trade supplies of Ukraine with the participation of sea transport, attention is focused on the export direction. But this does not narrow the scope of application of the results, since the delivery of imported goods is similar, only in the «mirror» version with respect to export.

Let's note that the transport and technological system can serve as the technological basis both for the entire delivery system and only for its part (Fig. 2). For example, if to talk about bulk, liquid or tare-piece cargo that is transported by sea in containers, their «containerization» can be carried out at the point of departure, in the port or at special staffing sites. Accordingly, from this moment the cargo enters the container transport and technological system.

Options of the transport and technological process in Fig. 2 are aggregated, since they are not detailed to the level of terminal operations, that is, they do not consider this process in transport nodes in detail. Given the fact that it is being examined from the point of view of the cargo owner and the possibilities of its choice. Terminal and other operations carried out in transport hubs, staffing sites, ports are not subject to management for the delivery organizer and cargo owner.

Two of the presented in Fig. 2 generalized options of the transport and technological process involve containerization and sea transportation on container ships. The third option involves the transportation of cargo on bulk carriers, general purpose vessels, tankers, refrigerators, depending on the specifics of the cargo. The fourth option is applicable for bulk cargo and uses a barge-towing [20] transport and technological system as a means of ensuring the delivery of cargo to the seaport. It should be noted that all four of the indicated options of the transport and technological process take place in practice for the export of grain and timber. Thus, the delivery of the same cargo can be carried out by various transport and technological processes, as well as using different transport and technological systems. Fig. 1 demonstrated only two of the possible options for using a transport and technological system using the example of a container and barge towing system as the most common in practice today in Ukraine.

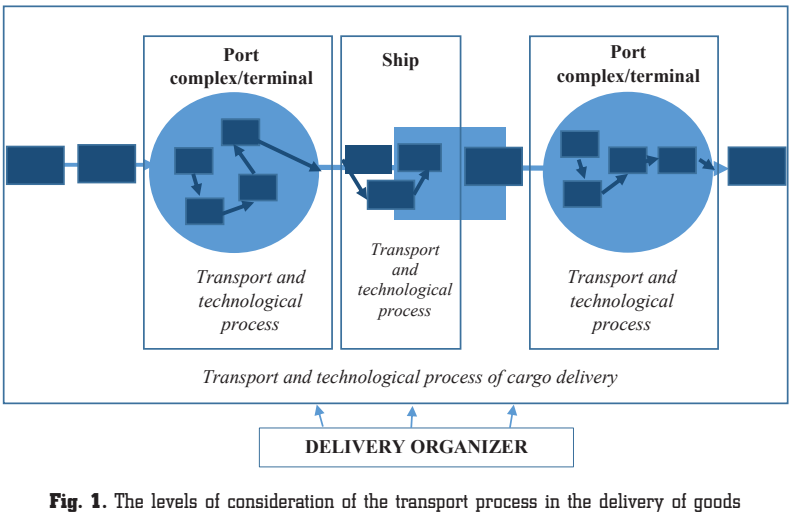

Fig. 1. The levels of consideration of the transport process in the delivery of goods

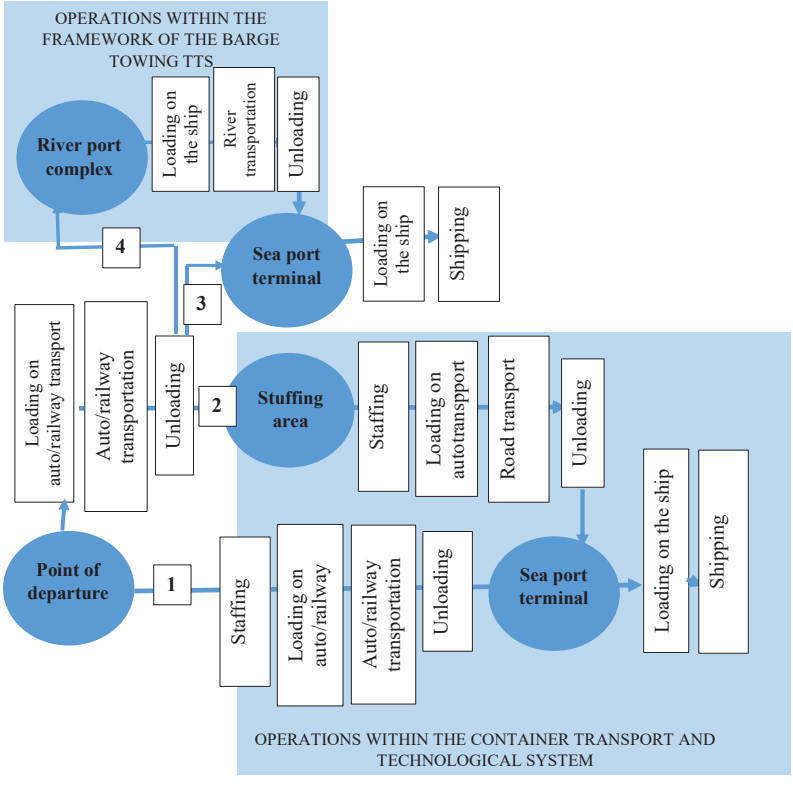

Fig. 2. Options of the aggregated transport and technological process of export cargo delivery with the participation of sea transport: TTS – transport and technological system; 1 – option for the delivery of goods in a container at all delivery sites; 2 – an embodiment of partial containerization of delivery; 3 – delivery option without the use of transport and technological systems; 4 – delivery option using a barge-towing transport and technological system

When solving the problem of choosing a transport and technological process option, first of all, it is necessary to determine the moment of its consideration in relation to the conclusion of a foreign trade contract, which clearly spells out «volume», «lot size», «geography», «time» and the exporter's liability line. «Geography» means the port of departure/destination, depending on the basis of delivery (in accordance with INCOTERMS 2020). In addition, the transport conditions of contact already determine the technology of transportation of goods, that is, the cargo is transported as bulk (liquid, piece-loaded) or containerized.

If the contract has already been signed, then, in fact, there is no possibility of choosing the option of a transport and technological process. At the same time, the main task from the point of view of the cargo owner is to ensure the level of efficiency that was implied in the formation of the terms of the foreign trade contract, and the necessary terms, and delivery volumes also in accordance with this contract. Thus, the variation of the transport and technological process of cargo delivery in its integral consideration is possible before the signing of the foreign trade contract. It is during this period of time that the freight owner-exporter determines for itself the most acceptable version of the delivery technology.

Let's note that the transport and technological process is tied to the scheme of cargo delivery, in the context of the geographical aspect of delivery. So, for example, presented in Fig. 1 option of the transport-technological process using a barge-towing transport-technological system is possible only if grain is exported through the port of Mykolaiv (Ukraine). Options using a container transport and technological system are possible if export is carried out through the ports of Odesa, Chornomorsk, Yuzhnyi (Ukraine).

Therefore, depending on the basis of delivery, the exporter either has or is not able to vary the «geography» of delivery and, accordingly, the transport and technological process (Fig. 3). So, if the sea component is paid by the exporter (for example, CIF, CFR conditions), then the exporter has great freedom of variation by the intermediate port and, accordingly, the transport and technological process. If the sea transportation is paid by the importer (for example, the FOB delivery basis), then the exporter is more limited in the choice of the transport and technological process.

Unlike road and rail transport, transportation of the same cargo by sea can be carried out not only by vessels of various specializations, but also by size, which, of course, affects the indicators characterizing the transport and technological process and the entire delivery as a whole. Depending on the specifics of the contract and the characteristics of the exporter as a cargo owner, the latter may or may not choose the size of the vessel in the same way as the discussion above regarding the aggregated transport and technological process.

Thus, the main factors that determine the options (option) of the transport and technological process of cargo delivery involving sea transport are:

– terms of the contract – the size of the consignment, the total amount of delivery under the contract, the basis of delivery, etc.;
– specifics of ports and port terminals – specialization, depth at berths, technical equipment;
– accessibility of transport and technological systems.

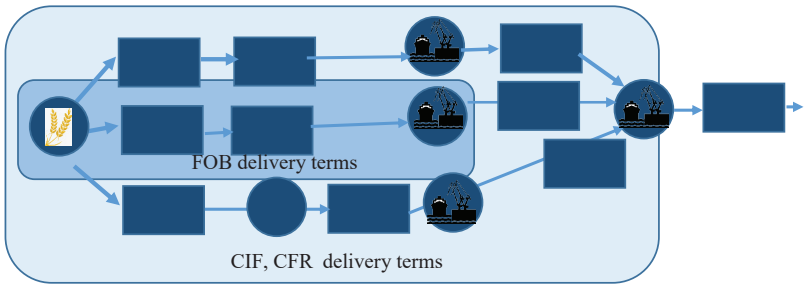

Fig. 3. The limits of the possible variation of the transport and technological process depending on the basis of supply for export

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7. SWOT analysis of research results

Strengths. The practical majority of the scientific results associated with the transport-technological delivery process are either focused on road transport or consider this process at the level of a particular site or participant in the delivery process (for example, a port terminal). Cargo delivery with the participation of sea transport enables multivariance in the use and combination of various transport technologies. And this, in turn, gives delivery organizers a wider range of opportunities to provide certain delivery parameters and performance indicators.

Weaknesses. These results are only the first stage in the process of a comprehensive study of the problem of optimizing the transport and technological process of cargo delivery. Therefore, the most practical interest is the following – a promising stage of the study – the development of appropriate optimization models.

Opportunities. Cargo delivery with the participation of sea transport, as a rule, is used in the transport support of international trade. Modern transport technologies and various types of transport and technological systems are widespread on a global scale. Therefore, the results of this study make it possible to increase the efficiency of transport support of foreign trade contracts due to the integrated consideration of various technologies within a single delivery system. Further development of these results is focused on optimizing the parameters of the delivery process in accordance with a given criterion and limiting conditions.

Threats. The research results do not require any material and technical base for their implementation, but only relevant information on possible transport and technological systems. This information is publicly available, therefore, its finding is not associated with any costs other than the time spent by a specialist who will use the results.

8. Conclusions

1. Two levels of consideration of the transport and technological process are established. The first is the level of individual participants in the cargo delivery process (for example, a port terminal, a sea carrier). The second is the level of the entire delivery system from the point of departure to the place of transfer of responsibility for the two parties to the foreign trade contract. The level of consideration of the transport and technological process determines the controllability of this process. In its integral consideration, the transport and technological one acts as a control object for the delivery organizer/cargo owner.

2. A correspondence has been established between the transport-technological systems and the transport-technological delivery process, according to which the latter can use several transport-technological systems as the technological basis. The main options of the transport and technological delivery process (for example, export) with the participation of sea transport by varying various transport and technological systems at different delivery sites are determined.

3. The boundaries of variation by the transport and technological delivery process depending on the basis of delivery are justified. For CIF, CFR conditions, the exporter has great freedom of variation by the intermediate port and, accordingly, the transport and technological process. In the case of FOB, the exporter is quite limited in the choice of transport and technological process.

The main factors that determine the options for the transport and technological process within the responsibility of the cargo owner:

– size of the consignment, the total amount of delivery under the contract, etc.;
– specifics of ports and port terminals – specialization, depth at berths, technical equipment;
– accessibility of transport and technological systems.

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