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AN APPROACH TO DETERMINE THE RATIONAL SCHEME OF DELIVERY FOR THE INTERNATIONAL CONSOLIDATED SHIPMENTS

The article deals with an approach for determining a rational scheme for the delivery of the international consolidated shipments taking into account possible alternatives involving the transport companies and terminal systems. The cost to consider the impact parameters have been proposed as a criterion for finding a rational scheme for the delivery of consolidated shipments.

Keywords: *rational scheme, delivery, consolidated shipments, cost, international transport.*

Problem statement

In the development of the domestic economy one of the key ways is the improvement of the country's transport system and the implementation of its powerful transit potential to ensure the European ties. This will be a significant contribution to the development of Ukraine due to the growth in transportation turnover and the multiplicative effect in other sectors of the economy [1].

The road transport quality affects the organization of continuous trade, satisfaction of public demand for goods, distribution rate, inventory size, cost level, production self-cost and trade profitability, procurement and production activities.

In the past few years, the crisis-weakened domestic demand has been influencing the activities of domestic carriers. Today, as the logistic operators note, the consolidated shipments' demand from industrial enterprises is growing. It should be emphasized that in many developed countries of Europe, in previous years the crisis had a positive effect on cost savings in the production process and encouraged the manufacturers to introduce the "just in time" approach. Today, the supply of raw materials and components for production, delivery the finished products to the buyer not only in a shorter time, but also at a specific hour, and in small batches, which obviously cannot happen without the consolidation of shipments, are actual for the road transport market in many countries [2].

Every year there is a tendency to expand the cargo market. Along with the increase in production volumes, the need arises to find and develop the most efficient ways for transporting goods. The issue of choosing a rational scheme of delivery of the international consolidated shipments has been not sufficiently studied at the present stage, and therefore it requires a preliminary study and analysis. In this regard, improving the efficiency of delivery of the consolidated shipments is an important research task.

Analysis of recent research and publications

Transportation is one of the basic branches of the economy. In 2017, transportation, warehousing, postal and courier activities accounted for about 6,6 % of GDP and 6,1% of the total employed population. Agriculture, coal, mining and metallurgy, chemical and food industry, industrial and house building, retail trade, communications and postal services, and defense are the most transportation-dependent industries [3].

Presently, the transport industry of Ukraine as a whole satisfies only the basic needs of the population and the economy in volume, but not in quality. The current state of the transport industry does not fully meet the requirements for the effective implementation of the European integration course of Ukraine and the integration of the national transport network into the trans-European one.

The national transport strategy of Ukraine for the period until 2030 determines the priorities for improving the quality of transport services, envisages bringing their level and infrastructure development closer to European standards, improving safety and reducing the negative environmental impact responds to the need to improve management reform and decentralization of tasks and functions of central executive authorities, the introduction of anti-corruption policy, corporate governance in the public sector [3].

The regions of Ukraine, as well as the whole world, require the constant supply of various resources and goods, delivery of equipment, materials, industrial goods and other resources in small lots, since their consumption is limited, and accumulation and storage are ineffective. At the present, the service sector and its transport component, which takes a significant position in all economic spheres, is moving to the upper level of the economic hierarchy. An important place in the transport service of the economy is related to the transportation of small-lot cargoes providing all its compo-

ment parts with the necessary resources, raw materials. Transportation in the field of consumption is of a special attention, since the cargo circulating there, as a rule, is formed and transported in small lots. Considering that transportation serves the vital needs of the population, it is socially significant and requires a constant attention [4].

The main advantages in concern of the consolidated goods are cost-effectiveness and convenience of transportation in this way. Substantial savings are achieved through the efficient use of cargo space. In this case, even air travel, which is generally very expensive, can be quite affordable. A transport company has the opportunity to save money on the delivery of consolidated goods, since, sending just one car to a certain point, it processes the several orders for cargo transportation at once. This reduces transportation costs, and hence the cost of shipping services, increases the number of customers and their loyalty to the company [5].

An important role in international transportation is played by warehouses, terminals, distribution centers, consolidation sites etc. The technological process in warehouses, which is based on a rational construction, accurate and consistent warehouse operations, continuous improvement of the labor organization and technological solutions, must meet the optimal parameters for the process speed, ensure the safety of goods, cost efficiency and a high level of the logistics service [6].

An analysis of publications that have studied the process of delivery of the international consolidated goods allows determining the main results and development directions:

- development of rational transport and technological systems for cargo delivery from current modeling methods [7–9];
- formation of effective technologies for the delivery of small and consolidated shipments in various types of traffic [10–13];
- introduction of terminal systems and distribution centers in the organization of delivery of small-lot cargoes [14–19];
- improvement of the logistics supply chain of goods taking into account the scale of orders and type of shipments [2, 20–23].

Thus, the theoretical studies of many scientists have shown that a well-developed market of logistics services with the appropriate logistics operators and the appropriate logistics infrastructure will allow to effectively implementing the technology of consolidated shipments for reducing the costs of all participants in the delivery process.

Aim of the study

The purpose of this study is to choose a rational scheme for the delivery of international consolidated

shipments with the minimal cost. To achieve this goal it is necessary to solve the following tasks:

- to develop the alternative schemes for the delivery of consolidated shipments;
- to determine the estimated function and the impact parameters;
- to make the analytical models for determining a rational scheme of delivery of the consolidated shipments.

Study material presentation

Current international conditions of logistics of freight traffic, to which Ukraine aspires, require ever-increasing attention and improvement. The efficiency and quality of freight transportation significantly depend on the optimization of the coordination processes of various modes of transportation, the rational distribution of traffic volumes between them, the timely formation of the necessary management decisions. First, special attention should be paid to the two most important indicators – the cost of transportation and terms of order processing when delivering the consolidated cargoes [24].

In general, the delivery of goods from a shipper to a consignee provides for the implementation of groups of operations to select the modes of transport, preparation of cargo for transportation, delivery to the terminal of the main transport, loading and unloading, and warehousing operations, transportation and transfer of cargo from one mode of main transport to another, transportation of goods from the terminal of the main transport to the addressee. When performing each group of operations, technical means, methods and techniques of operational organization can vary. Thus, a complex of mutually agreed technical, technological, economic, organizational, commercial and legal solutions to provide the most efficient transportation of goods is the transport and technological delivery system [25].

The formation of a set of alternative delivery schemes depends on the request flow parameters. For each order, transport company, terminals and customs facilities available in the service region are to be considered.

We offer two alternative schemes for the delivery of the international consolidated cargoes. The first scheme, “Scheme 1”, includes the following group of participants: a transportation company that delivers cargo in small lots from the shipper to the terminal; shippers (n is the number), a terminal that makes the consolidated shipments in the shipper's area; an international transport company that carries the international consolidated shipments; customs facilities (in the country of departure and destination, respectively); consignees (Fig. 1).

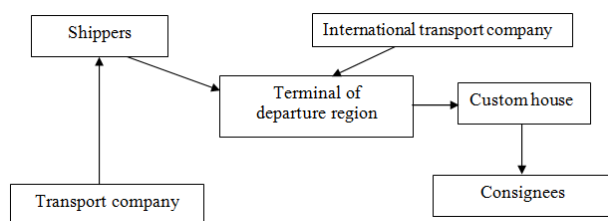


Fig. 1. Scheme of interaction of the participants to deliver the shipments with the departure region terminal – "Scheme 1"

The presented delivery scheme provides for the cargo consolidation at the terminal, and then, by road trains, – to the consignees. With this delivery scheme, the number of loading and unloading operations, and the time to wait for the terminal cargo accumulation increases. Under these conditions, the total delivery time increases. Consolidation of goods affects the reduction of transportation cost and the number of vehicles of small and medium capacity. When developing this delivery scheme, in addition to the transportation distance and volume, it is necessary to take into account the order's flow intervals for the transportation of the consolidated cargoes.

The second scheme, "Scheme 2", provides for the change of participants: shippers, an international transport company to collect the small lot shipments and to carry an international transportation; customs facility (in the country of departure and destination, respectively); a terminal in the region of destination in which the consignment is disband; a transport company that provides vehicles to transport the small shipments from the terminal; consignees (Fig. 2).

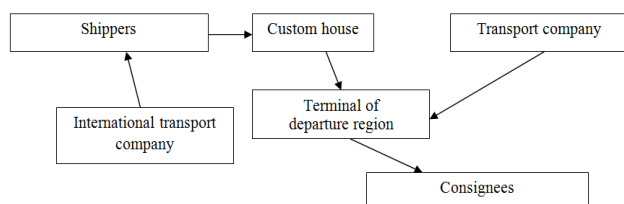


Fig. 2. The interaction scheme for participants to deliver the consolidated shipments using the destination region terminal – "Scheme 2"

It is advisable to use the scheme of delivery without a consolidation terminal when transporting of cargo up to 10 tons over a long distance. For transportation the vehicles of appropriate capacity should be used. The use of the vehicles contributes to improving the transportation productivity, reducing the fuel consumption by 1 tkm (1 t) and the transportation cost. In addition, it is possible to decrease the number of vehicles of small or medium capacity (up to 5 tons), and hence, the need for drivers.

The technological process of delivery of consolidated cargoes according to the presented schemes (Fig.

1, 2) can be grouped into the corresponding components:

- 1) providing the car to the place of loading (shipper, terminal of departure or destination);
- 2) loading the goods from the shipper;
- 3) carriage from shippers to the terminal of destination, as well as between shippers;
- 4) terminal operations (unloading, storage, cargo unit formation, disbandment, loading);
- 5) transportation in Ukraine (from shippers (from a warehouse) to customs in the territory of Ukraine);
- 6) customs procedures at the border (at the customs of departure and destination);
- 7) international transportation (from the customs border to the consignees, from the destination terminal to the consignee);
- 8) carriage between consignees and unloading of the relevant shipment.

To determine the rational delivery scheme for the international consolidated shipments it is necessary to consider the order size, transportation distances, order flow intensity, the procedure for some technological operations on loading, transportation, placing on the terminal, customs clearance and unloading.

The cost of delivery of the international consolidated goods when using the consolidation warehouse ("Scheme 1") will have the following form:

$$B_{\Sigma 1} = B_{vtTU} + B_{lcs} + B_{chdt} + B_{oc} + B_{ctST} + B_{chtc} , \quad (1)$$

where B_{vtTU} is the vehicular traffic cost from the transport company to the shipper, cargo transportation from the shipper to the terminal through the territory of Ukraine, UAH;

B_{lcs} is the loading cost from the shipper, UAH;

B_{chdt} is the cargo handling cost at the departure terminal, UAH;

B_{oc} is the customs operations cost, UAH;

B_{ctST} is the cargo transportation cost through a foreign state territory, UAH;

B_{chtc} is the cargo unloading cost from the consignee, UAH.

The vehicular traffic cost from the transport company to the shipper, cargo transportation from the shipper to the terminal and through the territory of Ukraine:

$$B_{vtTU} = S_{1km}^{sub} \cdot L_{vtTU}^{sub} + (S_{1tkm}^{term} \cdot L_{vtTU}^{term} + S_{1tkm} \cdot L_{vtTU}) \cdot q, \quad (2)$$

where S_{1km}^{sub} is the cost of submitting a vehicle to the shipper, UAH/km.

L_{vtTU}^{sub} is the distance from the transport company to the shipper, km;

S_{1tkm}^{term} is the cost of shipping through Ukraine from shipper to the terminal region of departure, UAH / ton-km;

L_{vtTU}^{term} is the distance of transportation on the territory of Ukraine (from the shipper to the terminal), km;

S_{1tkm} is the cost of shipping through the territory of Ukraine (from the terminal to customs), UAH / ton-km;

L_{vtTU} is the distance of transportation on the territory of Ukraine (from terminal to the customs), km;

q – the cargo order volume, t.

Loading costs from the shipper:

$$B_{lcs} = \frac{S_l \cdot q}{t_{lt}^{sh}}, \quad (3)$$

where S_l is the loader's operation one hour cost for cargo loading from the shipper, UAH/hour;

t_{lt}^{sh} is one ton of cargo loading time from the shipper, t/hour.

The departure terminal handling costs:

$$B_{chdt} = \frac{S_h^{ter} \cdot I_O \cdot q}{t_{lt}^{term}}, \quad (4)$$

where S_h^{ter} is handling cost per ton of cargo at the departure region terminal, UAH/t;

t_{lt}^{term} is one ton of cargo handling time at the terminal, t/hour;

I_O is the order flow intensity, t/hour.

Custom operation cost:

$$B_{oc} = (S_{cU} \cdot t_{lt}^{cU} + S_{cF} \cdot t_{lm}^{cF}) \cdot q, \quad (5)$$

where S_{cU}, S_{cF} is the cost of customs procedures at the Ukrainian and the foreign customs, respectively, UAH/hour;

t_{lt}^{cU}, t_{lm}^{cF} is the time of customs procedures per one ton of cargo at the Ukrainian and the foreign customs, respectively, hour/t.

The cargo transportation cost through the territory of a foreign state:

$$B_{ctST} = S_{1km}^F \cdot L_{vtF} \cdot q, \quad (6)$$

where S_{1km}^F is the 1 ton-km cost of carrying the cargo through the territory of a foreign state, UAH/tkm;

L_{vtF} is the transportation distance through a foreign state territory, km.

The unloading costs from consignees:

$$B_{chtc} = \frac{S_{ul}^{CP} \cdot q}{t_{lt}^{CP}}, \quad (7)$$

where S_{ul}^{CP} is the cost per one hour of the loading machine operation to unload the cargo from the shipper, UAH/hour;

t_{lt}^{CP} is the unloading time per one ton of cargo from the consignee, t/hour.

The cost of delivering the international consolidated cargoes under the “Scheme 2” will be as follows:

$$B_{\Sigma 2} = B_{vtTU} + B_{lcs_i} + B_{oc} + B_{termD} + B_{ctST} + B_{vtFCP} + B_{ulCP_i}, \quad (8)$$

where B_{vtTU} is the vehicular traffic cost from a transport company to the shipper, transportation through the territory of Ukraine, UAH;

B_{lcs_i} is the shipper's loading cost, UAH;

B_{termD} is the destination terminal handling cost, UAH;

B_{ctST} is the cargo transportation cost through the territory of a foreign state, UAH;

B_{vtFCP} is the cargo transportation cost through the territory of a foreign state to consignee's destination terminal, UAH;

B_{ulCP_i} is the cost of cargo unloading from the consignee, UAH.

All other cost items are to be determined as the costs under the “Scheme 1”.

The vehicular traffic cost from a transport company to the shipper, transportation through the territory of Ukraine:

$$B_{vtTU} = S_{1km}^{s1} \cdot L_{vtTU}^{s1} + \sum_{i=1}^n S_{1tkm} \cdot L_{vtTU} \cdot q_i, \quad (9)$$

where S_{1km}^{s1} is the submitting cost of an international company's vehicle to the first shipper, UAH/km;

L_{vtTU}^{s1} is the submitting distance of an international company's vehicle to the first shipper, UAH/km.

The shipper's loading cost:

$$B_{lcs_i} = \sum_{i=1}^n \frac{S_l \cdot q_i \cdot n_{lt}}{t_{lt}^{sh}}, \quad (10)$$

where n_h is number of loadings (corresponds to the number of shippers).

The destination terminal cargo handling cost:

$$B_{termD} = \frac{S_h^{termD} \cdot I_O^{termD} \cdot q}{t_{lt}^{termD}}, \quad (11)$$

where S_h^{termD} is the 1 ton of cargo handling time at the destination terminal, UAH/t;

I_O^{termD} is the order flow intensity to remove the cargoes from the destination terminal, t/hour.;

t_{lt}^{termD} is the destination terminal per one tone handling time, t/hour.

The cost to carry the cargo from the destination terminal to the consignee through the territory of a foreign state:

$$B_{viFCP} = S_{1km}^{CP} \cdot L_{viF}^{CP} \cdot q. \quad (12)$$

where S_{1km}^{CP} is the 1 ton-km cost of transporting the cargo through the territory of a foreign state from the destination terminal to the consignee, UAH/ton-km;

L_{viF}^{CP} is the transportation distance of bringing the cargo through the territory of a foreign state from the destination terminal to the consignee (the average value is to be taken), km.

From the analytical models obtained, it is necessary to carry out the statistical analysis of the model parameters using statistical data from transport and forwarding companies of the city of Kharkov, create the simulation models for determining the time for the relevant operations, conduct the experimental studies on a specific plan and generate the regression models.

Conclusions

It has been established that the development of a current market economy places new demands on how to improve the efficiency of the organization and management of material and financial flows. New forms and methods of organizing the logistics flows including consolidated shipments are needed. One of the ways to reduce the cost of goods and services is to reduce the delivery cost. Since the international road transportation of consumer goods is done by various shipments from a large number of shippers, the first task is to determine an efficient delivery scheme for the consolidated shipments taking into account the shipment formation time, transportation distances, and the number of process participants. Analysis of the current state of knowledge in the international road delivery of the consolidated shipments has demonstrated that the main direction to improve the technological process is coordination to form the consolidated shipments ensuring their timeliness and

reliability. From the literary sources, it has been revealed that the creation of consolidated deliveries by large logistic operators should be preceded by the demand from the industrial manufacturers which, with the aim of costs-saving, are implementing the "just in time" model in production.

Two alternative international schemes for the delivery of consolidated shipments have been presented. The first scheme – "Scheme 1" includes the following group of participants: a transportation company that carries cargo from the shipper to the terminal; shippers; a terminal that consolidates the shipments in the shipper's region; an international transport company; custom facilities; consignees. In the second scheme – "Scheme 2" – the organization of the consolidated shipment is taken directly using an international transport company (participation of the departure terminal is excluded), and the terminal of the destination region participates to distribute the consolidated goods to the consignee.

The process of determining a rational scheme for the delivery of international consolidated shipments is presented in the form of analytical models to take into account the influence of the relevant parameters on the elements of the delivery process and, in general, on the assessment parameter which is the delivery cost. A criterion for finding a rational scheme is proposed in relation to the cost to perform all the technological operations under the schemes.

From the technique presented, it is planned to conduct a statistical analysis of the input parameters in the future, draw up a simulation experiment plan taking into account changes in the values of external environment parameters and conduct the regression analysis.

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ПІДХІД ДО ВИЗНАЧЕННЯ РАЦІОНАЛЬНОЇ СХЕМИ ДОСТАВКИ ЗБІРНИХ ВІДПРАВЛЕНЬ У МІЖНАРОДНОМУ СПОЛУЧЕННІ

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У роботі було проаналізовано сучасний стан розробок та існуючих тенденцій щодо вибору раціональної схеми доставки збірних відправлень, в межах окремих країн та транспорту в цілому, що дозволило сформулювати основну мету дослідження даної статті.

Аналіз роботи транспортних підприємств та терміналів, дозволив виділити існуючі напрямки вдосконалення організації доставки збірних вантажів: визначення раціональної кількості технічних засобів терміналів та оптимізація сервісу по наданню транспортних послуг, але без врахування ефективної побудови схеми взаємодії між учасниками процесу. Встановлено, що при плануванні виробничої потужності системи доставки необхідно погоджувати логістичні цілі функціонування всього комплексу взаємодії з маркетинговими потребами споживачів.

Теоретичні розробки багатьох вчених показали, що добре розвинений ринок логістичних послуг з відповідними логістичними операторами та відповідною логістичною інфраструктурою, дозволить ефективно впроваджувати технологію збірних відправлень для зменшення витрат всіх учасників процесу доставки. Запропоновано дві альтернативні схеми доставки збірних відправлень у міжнародному сполученні.

Перша схема, "Схема 1", включає наступну групу учасників: транспортне підприємство, яке здійснює підвезення вантажу від вантажовідправника до терміналу; вантажовідправники; термінал, який здійснює об'єднання збірних відправлень в регіоні відправників; транспортне підприємство міжнародного призначення; митні переходи; вантажоодержувачі.

У другій схемі "Схема 2" враховується організація збірного відправлення безпосередньо за допомогою транспортного підприємства міжнародного призначення (участь терміналу відправлення виключається), а для розподілення збірного вантажу до вантажоодержувача приймає участь термінал регіону призначення.

Процес доставки збірних відправлень у міжнародному сполученні за відповідними схемами представлено у вигляді аналітичних моделей, які враховують вплив вхідних параметрів та зовнішніх факторів на елементи процесу доставки та в цілому на параметр оцінки - витрати. Запропонований критерій визначення раціональної схеми доставки враховує витрати на виконання всіх технологічних операцій, з урахуванням обсягу виконаної роботи (обсяг замовлення вантажу, відстані перевезення територією відповідних держав, інтенсивність надходження замовлень) та часу виконання відповідних робіт.

Ключові слова: раціональна схема, доставка, збірні відправлення, витрати, міжнародне сполучення.