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MODEL FOR DETERMINING THE OPTIMAL SIZE OF A MULTI-NOMENCLATURE CARGO BATCH, TAKING INTO ACCOUNT THE WEIGHT AND VOLUME CHARACTERISTICS OF THE TRANSPORT VEHICLE

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There is considered the cargo transportation dynamics that indicates an increase in the small consignments volume. There are determined the main criteria for small shipments delivery in relation to transport companies and their customers. Based on criteria there was proposed solution to optimize cargo deliveries. This solution is to consolidate cargoes deliveries with different nomenclature positions in a single vehicle. There was proposed the model for determining the optimizing consignment size task that allows loading the transport vehicle with several nomenclature positions of cargoes effectively.

Purpose. *To determine the consignment size using weight and volume characteristics of load units and the transport vehicle.*

Methodology / Methods. *In the article mathematical statistics method was used.*

Conclusion. *The algorithm for determining the optimizing consignment size task is proposed.*

Keywords: *small consignments; weight and volume characteristics; consumer demand; automobile transport.*

МОДЕЛЬ ОПРЕДЕЛЕНИЯ ОПТИМАЛЬНОГО РАЗМЕРА МНОГОНОМЕНКЛАТУРНОЙ ПАРТИИ ГРУЗОВ С УЧЕТОМ ВЕСОГАБАРИТНЫХ ХАРАКТЕРИСТИК ТРАНСПОРНОГО СРЕДСТВА

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Рассмотрена динамика грузоперевозок, свидетельствующая об увеличении объема малых партий грузов. Определены основные

критерии доставки малых партий грузов по отношению к транспортным компаниям и их клиентам. На основе этих критериев было предложено решение по оптимизации доставки грузов. Это решение заключается в консолидации поставок грузов различных номенклатурных позиций в одном транспортном средстве. Предложена модель определения задачи оптимизации размера груза, позволяющая эффективно загружать транспортное средство несколькими номенклатурными позициями товаров.

Цель. *Определить размер партии грузов с помощью объемно-массовых характеристик укрупненных грузовых единиц и транспортного средства.*

Методология / Методы. *В статье используется метод математической статистики.*

Результаты. *Предложен алгоритм определения оптимального размера партии грузов.*

Ключевые слова: *мелкие партии; объемные и массовые характеристики; потребительский спрос; автомобильный транспорт.*

Currently, the transport system must interact with other components of the cargo delivery transport system: the warehouse complex, suppliers and goods consumers [1, 2]. Thus, transport companies should be focused on achieving both their own goals and the goals of participants who interact throughout the whole supply chain from the goods manufacturer to their final consumer.

The finished products consumer is aimed at minimizing transportation costs. The main criterion that affects transportation costs is the rolling stock (automotive rolling stock). It is due to the efficient use of vehicles that the transportation rate (set by transport companies) is reduced.

For all supply chain participants, the most effective delivery option is to deliver a batch of an equal a fully loaded vehicle batch. This option allows, on the one hand, to effectively use rolling stock, which is one of the fundamental tasks in the activities of transport companies, and on the other – to deliver goods batch as quickly as possible from the manufacturer to the products consumer, bypassing the time spent on storage in intermediate warehouses [3, 4].

However, the cargo transportation dynamics indicates an increase in the small shipments volume. According to the research agency M.A. Research, the share of groupage cargo transportation in the Russian Federation in the cost volume structure of the commercial road cargo transportation market in 2017 amounted to 20.7%, and in 2020, this segment is expected to increase to 24.6%. The main factors for the growth of small consignments transportation by road are a decrease in the physical volume of one delivery of transported goods, a decrease in total costs by consolidating goods of different nomenclature positions from different shippers, and the territorial expansion of trade networks. Indicators that predict business activity (PMI) [5, 6] and the inventories level [7–9] also evidence this trend.

For goods transportation in small batches, the main thing for the customer (the consumer of goods) is, on the one hand, to minimize transportation costs, and on the other hand, there is a need to reduce the time for delivery of goods in small batches. When transporting small consignments of goods, additional necessary delivery participants appear (for example, warehouse complexes – for storage and distribution small consignments to one dispatch with a full load of vehicle in the direction of one consignee).

For transport companies, the main criteria for cargo transportation remain transportation costs reduction and need for efficient use of rolling stock. This criterion is not fundamental for goods transportation with a full load of vehicles. Consider the impact of the main criteria for small shipments delivery in relation to transport companies and their customers (Table 1).

Table 1.

Criteria for goods delivery in small batches

Criteria	Transport companies	Customers
Minimizing transportation costs	+	+
Minimizing delivery time	+	+
The efficiency of vehicles use	+	–

Thus, it can be noted from Table 1 that the customer is not interested in efficient use of vehicles when ordering goods delivery. In order to optimize the delivery of transport companies and at the same time not to lose customers, it is necessary to improve the delivery process in small

batches. Not all transport companies have the capacity to full the rolling stock fleet with trucks of lower load capacity. Therefore, one of the solutions to optimize cargo deliveries can be the consolidation of goods deliveries [10–13] with different nomenclature positions in a single vehicle. This solution will allow to use rolling stock efficiently, and to deliver goods in the required for customers volume, corresponding to the final consumers demand, which in turn will reduce the total logistics costs.

On water transport, a method was developed to determine the unit loading volume of cargoes and the number of units of cargoes of two nomenclature positions to improve the efficiency of vehicle cargo space using. The efficiency of vehicle exploitation depends on the utilization degree of cargo capacity (by volume) and load capacity (by weight).

A complex indicator that characterizes the efficiency of vehicle usage in terms of volume and weight is the unit cargo capacity. This indicator is fundamental in the tariff rates formation for small shipments transportations.

In addition to the compatibility of transported cargoes of different nomenclature items, the efficiency of vehicle using depends on the volume and weight goods characteristics. The main cargo characteristic is the unit loading volume that shows the average volume of one ton of cargo in a vehicle. It is this characteristic that determines whether the load is heavy (full load capacity use) or light (partial load capacity use) for the certain vehicle.

The purpose of this method is to determine the unit loading volume of cargoes and the number of units of transported goods in two nomenclature items for a particular vehicle.

In accordance with the transport characteristics of cargo spaces (loading capacity – weight and cargo capacity – volume) and load unit (dimensions, gross weight) there is determined the unit volume of the vehicle and load unit. The further calculated stacking coefficient on water transport takes into account the use of a cargo space that differs from a parallelepiped (i.e., the space between the cargo and the walls of the cargo space is additionally considered). This factor for palleted cargoes delivery by motor vehicles can be neglected, as discussed cargo in the integrated cargo units is approximated to the form of a parallelepiped, as the vehicle itself, i.e., cargo shape coefficient can be taken equal to one.

Comparing the unit loading volumes of cargoes and the vehicle allows determining which one of the two cargoes is heavy and which is light. Setting up a system of equations for load capacity and cargo capacity of the vehicle allows determining load of two types of cargoes.

The algorithm for calculating the effective cargo space use in a vehicle is shown in Fig. 1.

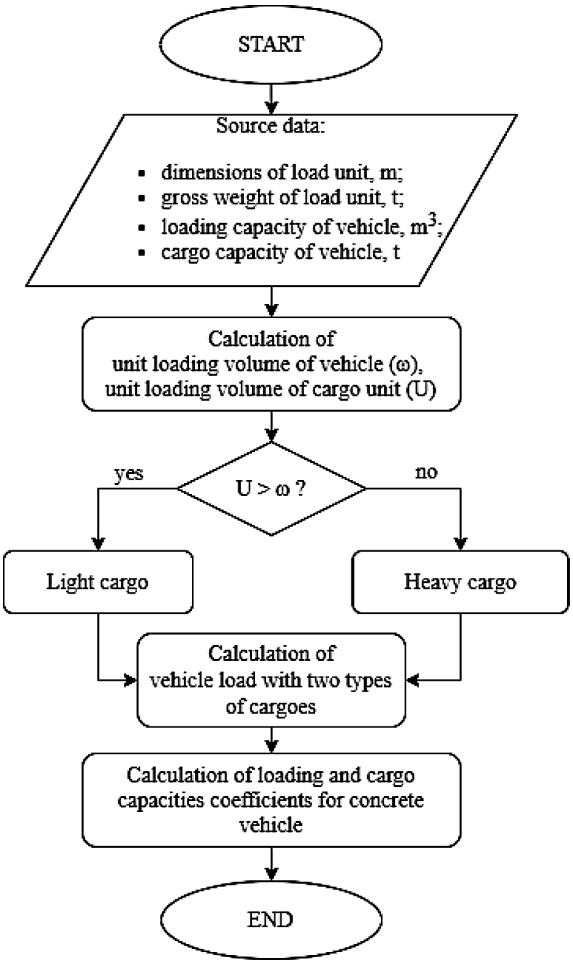

Fig. 1. Algorithm for efficient vehicle usage

Determining the optimal loading of a particular vehicle with cargoes of different nomenclature positions (using the method used in water transport) can also be used in road transport, taking into account adjustments. As the carriage of goods in small consignments may require a vehicle load cargoes with more than two nomenclature items, it is necessary to upgrade the approach with the possibility of loading goods of more than two items.

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