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EVALUTION OF THE SINGLE INTERCITY FREIGHT TRANSPORTATION WAITING TIME

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Abstract. *The example of vechicle operation on the pendulum intercity route during single freightages processing is considered. Two approaches to the definition of the single freightage waiting time by the carrier are proposed. These approaches allow to take into account the probability of the single freightage obtaining by the carrier during the different load level of the transport enterprise capacity.*

Key words: *single freightage, intercity freight transportation, waiting time, freight flow.*

ОЦЕНКА ВРЕМЕНИ ОЖИДАНИЯ РАЗОВЫХ ЗАЯВОК НА ПЕРЕВОЗКУ ГРУЗОВ В МЕЖДУГОРОДНОМ СООБЩЕНИИ

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Аннотация. *Рассматриваются теоретические подходы к определению времени ожидания разовой заявки. Предложенные подходы учитывают вероятность получения перевозчиком разовой заявки на перевозку грузов на маятниковом междугородном маршруте при разном уровне загрузки провозных возможностей автотранспортного предприятия.*

Ключевые слова: *разовая заявка, перевозка грузов в междугородном сообщении, время ожидания, поток заявок.*

ОЦІНКА ЧАСУ ОЧІКУВАННЯ РАЗОВИХ ЗАМОВЛЕНЬ НА ПЕРЕВЕЗЕННЯ ВАНТАЖІВ У МІЖМІСЬКОМУ СПОЛУЧЕННІ

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Анотація. *Розглядаються теоретичні підходи до визначення часу очікування разового замовлення. Запропоновані підходи враховують ймовірність отримання перевізником разового замовлення на перевезення вантажів на маятниковому міжміському маршруті за різного рівня завантаження провізних можливостей автотранспортного підприємства.*

Ключові слова: *разове замовлення, перевезення вантажів у міжміському сполученні, час очікування, потік замовлень.*

Accession

The volume of orders for freight has significantly increased under the influence of medium, small businesses and private business. This is especially true of cargo transportation in intercity, because the large proportion of the commodity companies performed at the regional level, which explains the large number of single orders for transportation in the intercity. One reason for the popularity of this form of cargo using contracts as «single order» is a powerful development of information technology, which led to the emergence and successful operation of specialized logistics sites.

The placing orders for transportation in intercity transport and for information portals allowing cargo to save time searching for a transport company that is ready to take orders for execution and to avoid the need for signing long-term contracts with the carriers.

As for the trucking companies, in this case the situation is different. The stochastic nature of the single receipt of orders led to the need for carriers to monitor constant change orders main parameters which were declared for the execution. In addition, the performance of long-distance transportation for the single orders for the duty-auto enterprises was added the need to download the perspective of the vehicle in reverse.

The definition of the rational values timeout orders for shipping in intercity motor enterprises is the important task, which will solve the carriers choose the right strategy behavior when serving one-time orders for transportation in intercity under conditions of high competition in the transport market.

The analysis publications

Many scientists research the subject of the functioning single market orders for the freight.

In [1–5] analysis service contracts for the cargo arriving randomly through the various sources usually played with the position forwarding companies and it is not paid enough attention to the consideration of behavioral strategies in making carriers to fulfill such orders.

The authors of [6-8] in the study of the transport of goods by one-time orders underscore the need to identify features of formation the demand for trucking companies and offer a variety of mathematical models for their determination. Taking into account the random nature of orders for cargo that shape the demand for transport services market, greatly simplifies the process of planning transportation in intercity, but it does not allow the hauliers to solve the problem of reverse loading the vehicle.

The work [9] deals with the question of routing the empty vehicle is an important element of long-distance freight transport in the opposite direction. However, the emphasis was considered in [9] models again put on the parameters of demand for the trucking companies. There are no recommendations on the length of time waiting orders for transportation in intercity directly affect the financial costs associated with trucking companies out of basic storage car now and paying the driver the travel allowance is not provided.

The relevance of the questions waiting times for the orders shipping as one of the solutions to the problem of the model selection behavior of carriers in the market languages has sponsored studies [10–12]. However, depending reliabilities are not universal and can not be used in planning long-distance trucking companies transport in the direct and reverse directions.

It should be noted that none of the reviewed scientific papers are not proposed the integrated approach to the definition of rational values timeout orders shipping intercity traffic.

This situation makes it impossible to achieve significant progress in the rational planning of trucking companies serving the market segment of single orders of long-distance transportation.

The purpose and the problem statement

One way to improve the level of the long-distance transportation is to determine its rational time parameters. Thus, the aim of the paper is to develop the approaches to determine rational values timeout single orders for the transportation in the intercity.

The most common example of the car's performance of the long-distance transportation is the pendulum route. When servicing a single order for the intercity route pendulum vehicle carries cargo between two points: i and j.

The rare case is when the carrier receives order for shipping and for the i and for the j-points. Typically, the carrier has the orders for the long-distance transport of cargo only for the i-point. Caught in the j-point, the car idles for a long time waiting for the orders for the shipping back.

Given the intensive development of the information technology is the most common informing way for the carriers of cargo in transit became specialized logistics sites.

When placing the order for cargo transportation in intercity logistics on site, the information goes to a single database capabilities which are used to assign a specific request specific vehicle.

The controllers that are informed about the need for the transportation of cargo in a single database, perform the distribution of orders between cars that are willing to accept it for execution.

The probability of simultaneous multiple orders of the one carrier is very small compared with the probability of receipt of the single order. Therefore, simultaneous different carriers single orders for transportation create the simple flow of the orders.

The important element in the maintenance of single orders is to determine the level of loading car carrier at the points between the carried intercity transportation. The level of freight loading capacity characterizes the degree of the satisfaction of the orders for freight cars which are ready to take their performance to the period of the cargo, the dispatcher and the carrier.

Having the information about the total number of orders which is presented for the execution, and the total number of the available vehicles, the controller performs equally-probable distribution of the total number of the orders. It should be noted that it is for the manager who makes the distribution of orders for the shipping is «screening» the total flow of the orders in the future can be considered as the simplest [13]. The stationary and the ordinariness are the basic properties of the simple order's flow [14].

In this study it is believed that the cargo takes orders shipping to the single database at the time when the dispatcher can take it for the execution, i.e. the period of the cargo owner, manager and the carrier are synchronized.

The vehicle is considered ready for the shipment after the driver's previous order execution notification to the dispatcher.

Thus, the definition of the load capacity of the freight carrier for the item which starts servicing the single order for shipping in the intercity and taking into the account the probability of such an order by the carrier at points between which are carried the intercity freight will form the approach of the waiting times single order for the transportation in the intercity.

The construction of the mathematical models of the single latency orders for the transportation in the intercity

Let λ intensity of the orders for cargo transportation to the direction from i to j (with j in i), then the intensity of the number of the orders, which accounts for one car and in-fact (j-so) point can be calculated by the following formula.

$$I^{i(j)}_{\text{avt}} = \frac{\lambda}{A}, \quad (1)$$

where $I^{i(j)}_{\text{avt}}$ – the intensity of the number of the orders, which accounts for one car and in fact (j-so) point unit. / avt. $\cdot h$; λ – the intensity of the orders for the direction from i to j or from j to i, unit. / h; A – the total number of the vehicles are used for the transportation direction from i to j or from j to i, avt.

The level of the car loading and (j-back) section of the notification of the readiness to dispatch the driver to take him to the performance will be equal $\rho_{i(j)}$.

$$\rho_{i(j)} = I^{i(j)}_{\text{avt}} \cdot T, \quad (2)$$

where T – the average time of the order for the shipping to the direction from i to j or from j to i, h.

Since the operation of the vehicle on the pendulum intercity route services are provided only between the points and j, it is logical assertion that the average time of the order to shipping for the direction from i to j and for the direction from i to j will be the permanent part of the (2), T = const.

Carrying out the long-distance traffic can have two situations that characterize the degree of the total number of the orders to the stated performance cars which are ready to take them into the execution.

In case of the the number of orders that occur in one car less than the number of cars ready to take the order for the execution, the needs of cargo in transit will be fully satisfied. The level of vehicle load paragraph, which begins with the single transport service orders for the shipping, in this situation it will be equal to the values the range from zero to one.

$$0 < \rho_{i(j)} < 1 . \qquad (3)$$

If the number of the orders that occur in one car, more than the number of cars ready to take the order for the execution, the level of the vehicle load equals or exceeds it's units. The emergence of this situation indicates the accumulation of the orders that are not operated.

$$\rho_{i(j)} \geq 1 . \qquad (4)$$

The important step that precedes the development of the rational approaches to determine the values of the single orders latency for the transportation in the intercity, is to determine the probability of the carrier order at the points between the shipment of the goods.

Therefore, the probability of the receiving the order for the shipping to the car carrier and (j) section of the notification of the driver manager willingness to accept the orders for the execution for both conditions (3) and for the condition (4) is P_1.

$$P_1 = \rho_{i(j)} . \qquad (5)$$

When the condition (3) is the possibility that the carrier does not receive the order in $i \setminus j$ points after the confirming the readiness to dispatch the driver to take the orders for the execution equals P_2

$$P_2 = 1 - \rho_{i(j)} . \qquad (6)$$

The probability that the carrier does not receive the order for the shipping and in i to j with the condition (4) is determined. It is based on the properties of simple flow of the orders and is P_3.

$$P_3 = e^{-\rho_i} . \qquad (7)$$

After the determining the level of the vehicle, the load carrier and the probability of receiving the request, at the points between the intercity transportation is carried, it is possible to go to the development of rational approaches determining the values of the single orders latency.

The approach of waiting times for the single orders for transportation in intercity is the assumption of Poisson distribution flow of the orders accounted for one car. As the result, the lack of the actions as one of the basic properties of the simplest Poisson flow, one can assume that the next customer waiting time in the elementary stream has the same distribution as the time between the receipt of the orders in the neighboring stream. This is confirmed by the following expression

$$P\{t_w > \Delta t\} = P\{T > x + \Delta t,\, T > x\} = \\ = \frac{P\{T > x + \Delta t,\, T > x\}}{P\{T > x\}} = \frac{P\{T > x + \Delta t\}}{P\{T > x\}} = \\ = \frac{e^{-\lambda(x+\Delta t)}}{e^{-\lambda x}} = e^{-\lambda \Delta t}, \qquad (8)$$

where t_w – waiting time for the next order of the receipt transportation for the direction from i to j (from j to i) in the elementary stream of the orders, h; Δt – the time between the end of the previous order and the time the decision to perform next, h; T – the execution time for shipping to direction from i to j (from j to i), h; λ – the intensity of the orders for the direction from i to j (from j to i), unit. / h.

Developing the first approach to determine the average waiting time of the single orders for the transportation in the intercity considered the case where the number of the orders suit the one car, less than the number of cars ready to take on the order for the execution. This situation is typical for the low intensity of the one time receipt of the orders for the transportation of goods at the point from where the orders of the transportation services begin.

So, if the carrier was commissioned to the transport cargo and in $i \setminus j$ points P_1, there is no need to wait.

$$t_{w1} = 0 . \qquad (9)$$

In the case of non-receipt of the order to the carrier in i to j paragraph after the notice of readiness to dispatch the driver to take the order for the execution, latency car cher-preferential order will be equal to the timeout regular occurrence in order of the disputcher's direction from i to j (from j to i), starting from some time between the appearance of neighboring orders flow.

$$t'_{w1} = \frac{1}{I^{i(j)}_{\text{avt}}}. \qquad (10)$$

Therefore, a general view of the average waiting time single order T'_{w1} considering the likelihood of the order's receipt by the carrier at the level of transport vehicle load which is not exceeding one, can be represented in following

$$T'_{w1} = \begin{cases} t_{w1},\, P_1 = \rho_{i(j)}; \\ t'_{w1},\, P_2 = 1 - \rho_{i(j)}. \end{cases} \qquad (11)$$

Analyzing the work of one car for the long-distance route, we can say that the process of obtaining the order by the carrier after the distribution controller is a queuing system with input simplest flow of orders from the exponential distribution of the scrap timeout, which has the completed mathematic mode [15].

$$\begin{aligned} M(T'_{w1}) &= \cdot\rho_{i(j)} \cdot t_{w1} + (1-\rho_{i(j)}) \cdot t'_{w1} = \\ &= \rho_{i(j)} \cdot 0 + (1-\rho_{i(j)}) \cdot t'_{w1} = \\ &= (1-\rho_{i(j)}) \cdot t'_{w1}. \end{aligned} \qquad (12)$$

Graphical interpretation of this case is shown in fig. 1.

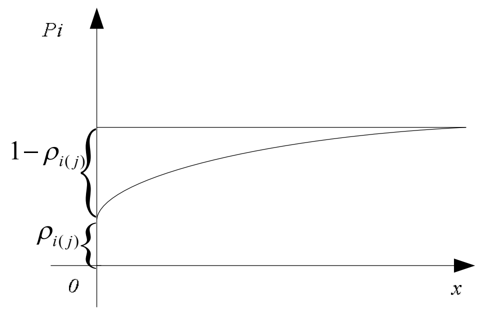

Fig. 1. The average waiting time schedule

The considered situation is the most successful for the carrier, as the flow of the orders conventionally configured for orders of the specific car, which explains the lack of need for the low cost or the waiting time waiting for the broadcast.

In developing the second approach to determine the average waiting time single orders for transportation in intercity considered the case where the number of orders in one is on the car, more than the number of cars ready to take on the broadcast for the execution. This situation indicates accumulation of the orders that are not operated due to lack of cars that are ready to take your order for the execution.

So if the carrier was commissioned to the transport cargo and in *i/j* point P_1, then, it is similar to the first approach, the need to order it disappears the waiting time. The single order's timeout for the shipping in the intercity will be equal t_{w2}.

$$t_{w2} = t_{w1} = 0. \qquad (13)$$

In the case of non-receipt of the order to the carrier in *i/j* points, including the waiting time, it will be equal to order the car t'_{w2}

$$t'_{w2} = \frac{1}{I^{i(j)}_{\text{avt}}}. \qquad (14)$$

So the general form of the middle latency order using the second approach can be represented as follow

$$T'_{w2} = \begin{cases} t_{w2},\, P_1 = \rho_{i(j)}; \\ t'_{w2},\, P_3 = e^{-\rho_{i(j)}}. \end{cases} \qquad (15)$$

The expectation of the average waiting time in order to use the second approach will be equal

$$\begin{aligned} M(T'_{w2}) &= \cdot\rho_{i(j)} \cdot t_{w2} + e^{-\rho_{i(j)}} \cdot t'_{w2} = \\ &= \rho_{i(j)} \cdot 0 + e^{-\rho_{(j)i}} \cdot t'_{w2} = e^{-\rho_{i(j)}} \cdot t'_{w2} \end{aligned}. \qquad (16)$$

The situation which is overlooked in the second approach of waiting times for the orders shipping in the intercity is less successful for the carrier. As to meet all the orders for the transportation except the car carrier are involved the additional vehicles, increasing competition for the single order from input stream of the orders. In this case the time waiting for the orders carrier increases significantly.

Using the proposed approaches of the single orders' waiting time for the transportation in the intercity will improve the level of long-distance traffic and achieve the significant progress in the defining rational behavior strategies trucking companies in the transport market services.

Conclusions

Analysing the literature in the direction of transport services in the single orders for the transportation showed almost the complete lack of scientific works which are devoted to the study of patterns downtime vehicles awaiting the orders for the shipping intercity traffic.

The organization of long-distance freight traffic as possible cases of excess and lack of transportation capacity carrier, depending on the prospect of the single order for the shipping, each of the points which are carried the intercity transportation. This situation explains the need for the different approaches of the waiting times of single orders for the transportation in the intercity.

The dependences allow to estimate the average waiting time for the orders shipping in the intercity which are based the segment of patterns of the single orders that can be defined using the databases logistics sites.

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