Statement and Mathematical Model of the Problem of General Service in the Transportation of Cargo by Motor Vehicle

Muratov A. X.
Termez State University

Abstract: In the article, the main indicator that determines the efficiency of the process of sending and receiving goods of the general service system is the time of stopping vehicles at checkpoints. The distribution of time intervals between the times of arrival of road transport at the point of departure by the indicative law is given.

Keywords: vehicle, freight, efficiency, traffic flow, service, inefficient waiting time, shipping cost.

One of the main problems of road transport is to increase the efficiency of transportation, and the growing demand for the delivery of goods requires a radical change in the activities of road transport enterprises. Consumers have the opportunity to choose a carrier, which is done in favor of those who are willing to provide a wide range of road services, high quality and affordable prices [1].

The structure, content and sequence of operations performed at shipping and receiving points are not the same. The structure of operations is formed depending on the type of transport routes, vehicles and loading and unloading vehicles, the system of sending and receiving, the routes of goods sent or received at the points. As the content and sequence of operations differ, they need to be grouped according to certain principles.

One of the main indicators of the efficiency of the process of sending and receiving cargo is the time of parking of vehicles at these points.

In the process of transportation, the service intensity of the points of departure (acceptance) should correspond to the time intervals of their entry into the service system, which is formed depending on the number of allocated vehicles. Otherwise, the inefficient waiting time of either points or vehicles will increase [2]. The process of sending and receiving goods by road has certain technical, technological and organizational features.

There are two main types of work performed at shipping points:

- technical and technological works, loading and unloading of the car, opening (closing) the sides, fastening the cargo to the body, weighing the car with or without cargo, moving the car at the point of departure (acceptance), etc.;
- Organizational and administrative work - the preparation of documents for the shipment or receipt of goods, the organization of rest or meals for drivers for a certain period of time, etc [3, 4].

The processes of sending and receiving cargo at points consist of a set of various elementary operations. Such operations that occur in the practice of transportation include:

- waiting in line to start various tasks;

- measuring the weight of the vehicle itself or its load;
- preparation of cargo for shipment and their separation, determination of quantity (quantity);
- preparing the car for receiving cargo: opening the sides, preparing awnings for closing the cargo, etc.;
- loading (unloading) of goods on the car, closing of boards and awnings, etc.;
- Completion of documents - waybill, freight document, various accounting journals, making certain entries and indicators.

The service system serves the incoming traffic flow in the form of various operations. Every vehicle included in the service system is a service applicant. Cars entering the point are treated as an influx of incoming applicants. In solving practical problems related to the analysis of incoming traffic, it may be more convenient and effective to study the distribution of intervals between the number of vehicles in the interval t instead of the interval k in the interval of subsequent vehicles [5].

In a normal incoming flow, we find the law of distribution of the interval time u between the entry times of two vehicles entering in series.

According to Poisson's law, the probability that no vehicle will enter during the t interval after the entry of one of the vehicles is expressed as follows:

$$\mathrm{P}_o(t) = e^{-\lambda t} \quad (1)$$

However, this probability is equal to the probability that the random variable is not smaller than the magnitude, i.e.:

$$P(u \geq t) = e^{-\lambda t} \quad (2)$$

From this formula (2) we find that the distribution function $F(t)$ of a random variable u is,

$$F(t) = P(u < t) = 1 - P(T \geq t) = 1 - e^{-\lambda t}. \quad (3)$$

Differentiating the formula (3) above, we obtain the distribution density of the random variable u $f(u) = \lambda e^{-\lambda u}$ or in general $f(t) = \lambda e^{-\lambda t}$ (4).

Hence, the time interval (interval) between the entry of any two adjacent vehicles in a normal flow is represented by the law of distribution of the parameter λ. This exponential law is given in the differential form in formula (4). The results show that the situation in which the flow of vehicles under analysis is close to the normal flow is the frequency (m_i) and the frequency ($m_i(n)$) of the time interval between the arrival of the next vehicle (integral) (3) or differential (4). Is the distribution according to the indicative laws given in the views.

Thus, in the analysis of the input current, it is necessary to observe and determine the time interval between the entry times of motor vehicles, to determine the amplitude of oscillation of its values, to divide this amplitude into intervals and group the intervals between them. If the distribution of the repetition frequencies of the intervals determined on this basis is represented by the exponential law; in which the incoming flow being analyzed is a normal flow.

It has been mathematically proven that a simple current with a parameter λ obeys Poisson's law.

$$P_k(t)=\frac{(\lambda t)^k}{k!}e^{-\lambda t} \qquad (5)$$

Let us consider the example of Surkhan Industrial Construction in which a simple current with parameter λ obeys Poisson's law. $j \in J=\{1,2,3\}$ is transported to consumers from the point of departure of the company "Surkhan Sanoat Qurilish". Freight is transported to consumers from the point of departure of the company "Surkhan Sanoat Qurilish". Transportation is carried out by self-propelled trucks in volumes corresponding to the volume in tons $Q_j=\{200,\ 300, 150$ ($j \in J=\{1,2,3\}$). The actual average load-carrying capacity of a vehicle is $q_н \gamma_{cm}$=20 tons, the average loading time per vehicle is t_o=9 min, and the average loading time per vehicle is t_m=9 minutes. The operating time of the vehicle, consignor and consignee is T = 8 hours.

We calculate the traffic flow rate (λ_j) from each j -consumer to the shipping address:

$$\lambda_j=\frac{Q_j}{q_n\,\gamma_{cm}\,T}, \qquad j\in\{\overline{1-3}\} \qquad (6)$$

$$\lambda_1=\frac{200}{20\cdot 1{,}0\cdot 8}=1,25; \qquad \lambda_2=\frac{300}{20\cdot 1{,}0\cdot 8}=1{,}875; \qquad \lambda_3=\frac{150}{20\cdot 1{,}0\cdot 8}=0{,}9375;$$

The distances from the shipping address to the consumer object are given in l_j={10, 15, 22} km, respectively, and the average technical speed standards of the vehicle on each consumer route V_j^T ={24, 24, 36} km/h.

We calculate the time t_j spent per cycle for each j consumer:

$t_j=t_o+t_m+\frac{2l_j}{V_j^T}+\bar{t}_{wait}$ (7) at the beginning we assume the waiting time as $\bar{t}_{wait}=0$:

$$t_1=(0{,}15+0{,}15)+\frac{2\cdot 10}{24}=1{,}13\ hour;\ t_2=0{,}3+\frac{2\cdot 20}{24}=1{,}97\ hour;\ t_3=0{,}3+\frac{2\cdot 22}{36}=1{,}52\ hour;$$

As a result, the number of cars required for each consumer is found m_j, i.e.

$$m_j=\lambda_j t_j \qquad (8)$$

$m_1=\lambda_1\ t_1=1{,}25\cdot 1{,}13=1{,}413;$ $m_2=\lambda_2\ t_2=1{,}875\cdot 1{,}97=3{,}6$;
$m_3=\lambda_3\ t_3=0{,}9375\cdot 1{,}52=1{,}425;$

The number of cars needed for all consumers is determined:

$$m=\sum_{j=1}^{j_{ox}} m_j=m_1+m_2+m_3=1{,}413+36+1{,}425=6{,}5\approx 7\,auto. \qquad (9)$$

It also determines the average intensity of traffic from all directions:

$$\lambda = \sum_{j=1}^{4} \lambda_j = 1{,}25 + 1{,}875 + 0{,}9375 = 3{,}5. \quad (10)$$

The average intensity of a vehicle entering the system is determined:

$$\lambda' = \frac{\lambda}{m} = \frac{3{,}5}{7} = 0{,}5 \quad (11)$$

Here is a distribution histogram of the time intervals of arrival of the motor vehicle to the loading vehicle (Table 1).

Table 1 Distribution of time intervals between the times of arrival of road transport to the point of departure by the indicative law.

ξ	0	1	2	3	4
$X = k$ $P_n(k)$	$e^{-\lambda}$	$\lambda e^{-\lambda}$	$(\lambda^2 / 2!)e^{-\lambda}$	$(\lambda^3 / 3!)e^{-\lambda}$	$(\lambda^4 / 4!)e^{-\lambda}$
	1,648	0,82	0,21	0,034	0,004

Hence, the observed incoming current can be calculated as the Poisson current with $\lambda = 3{,}5$ parameter.

The effectiveness of the overall service system is assessed on the basis of various criteria. In most cases, the criteria of practical importance are the sum of the costs per ton of cargo transported (sent or received) or the hourly working hours of service points and vehicles.

Conclusion. Approaches and models of gross service theory can only be applied when the flow of vehicles entering the system is manifested as a simple Poisson flow. It is necessary to adjust the indicators of access flow to the service system of vehicles and the serviceability of points. As a result, the time spent on vehicles and service points will be reduced and the volume of freight will increase.

References:

1. Kholikberdievich, M. A., & Turdalievich, K. A. (2021). Improving the process of delivering scattering loads to the construction objects by using automobile transport. Harvard Educational and Scientific Review, 1(1). Pages 107-117. https://zenodo.org/record/5670145#.Yl0ze8jP3IU

2. Butaev Sh.A., Sidiknazarov K.M., Murodov A.S., Kuziev A.U. (2012). Logistika (Etkazib berish zanjirida oqimlarni boshqarish). -T.: “Ekstremum Press”, 2012.-577 b.

3. Kuziev A.U., Muratov A.Kh. Improving the method of delivery of construction cargo in autotransport. ACADEMICIA: An International Multidisciplinary Research Journal Vol. 11, Issue 8, August 2021. 207-216 pp. https://indianjournals.com/ijor.aspx?target=ijor:aca&volume=11&issue=8&article=038

4. Juraev M.N. Teoreticheskie predposylki dlya primeneniya kombinatornogo metoda diskretnyh reshenij zadachi racional'nogo raspredeleniya avtotransportnyh sredstv po radial'nym marshrutam. Sovremennaya nauka: aktual'nye voprosy, dostizheniya i innovacii. Penza, 05 iyunya 2019. 21-26 s. https://www.elibrary.ru/item.asp?id=377906795.

5. Kuziev, A. U., Alikulov, S. R., Muratov, A. X., & Komilov, A. L. (2019). Statement of Optimization Vehicle Routing Problems on Transport Network. International Journal of Advanced Research in Science. Engineering and Technology, 6 (12).