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Key performance indicators for transport

In connection with the intensive development of transport technologies, there has been a tendency to minimize the influence of man in transport system. In recent years, various aspects of planning the activities of transport processes with the help of various vehicles have been actively studied.

A significant part of the scientific works of domestic and foreign authors is devoted to the problems of studying the performance of transport. A systematic analysis of the intensity of passenger traffic, productive labor, speed indicators is devoted to the analysis, classification, planning of passenger traffic [1, 2]. In [3, 4] transport units. In the article the main indicators of transport work are considered, the strategy of the expediency of using the calculation of the cost price of the transported passenger is developed.

Planning, calculation and analysis of transport activities is impossible without a set of indicators with which to measure the volume and quality of it`s work. In modern times, each mode uses it`s own system of indicators that determine its specificity, but there are groups of indicators that are uniform for all modes of transport and for generally accepted planning organizations.

This category includes transport performance.

To find the volume of transport operations, the following indicators are used:

- cargo turnover (tone-kilometers);
- passenger transportation (number-person);
- passenger turnover (passenger-kilometers).

Calculations for these indicators are usually calculated according to the growing index for every day, decade, month, quarter, year. The volume of passenger transportation for the year is calculated by the formula:

$$a_1 + a_2 + \cdots a_n = \sum a \quad (1)$$

where $a_1 + a_2 + \cdots a_n$ – is the number of passengers (transported), respectively, from the first, second …n-point.

Passenger traffic is found as the sum of the number passengers for a certain distance of their transportation and is found by the formula:

$$a_1 l_1 + a_2 l_2 + \cdots a_n l_n = \sum al \quad (2)$$

where l_1, $l_2 \ldots$ l_n – respectively, the range of the transported group of passengers.

When planning, analyzing and calculating the passenger transportation range is often used, which is calculated:

$$l_{cp} = \frac{\sum al}{\sum a} \quad (3)$$

The intensity of passenger traffic is estimated by the index of passenger load, which is found by the formula:

$$l_a = \frac{\sum al}{l_e} \quad (4)$$

where l_e – the operating length of the network as a whole.

An important quality indicator of the transportation work for each mode of transport is the speed of delivery of passengers throughout their travel from the point of priority dispatch to the destination.

If the average range of transportation of the one passenger is known and the average time that is intended for the carriage of one passenger from the destination point, then the speed of delivery is determined by the formula:

$$V_{\partial ocm} = \frac{l_{cp}}{t_{cp}} \quad (5)$$

The speed of delivery for passengers is found using the formula:

$$V_{\partial ocm} = \frac{\sum al}{\sum at} \quad (6)$$

where $\sum al$ – passenger turnover; $\sum at$ – the total time in passenger-hours spent on transporting passengers along the entire route of travel.

The prime cost of transportation of passengers on any of the modes of transport is calculated by the formula:

$$S_{m.км.} = \frac{C_e}{\sum al} * 10 \quad (7)$$

where C_e – this is the operating coast for the calculated period in UAH; $\sum al$ – this is the completed passenger turnover for a certain period of time.

In accordance with the existing planning the following is added to formula (7):

- on railway transport (all operating coast that were associated with the transportation);
- on maritime transport (expenses for providing watercraft and operation of the transport fleet);
- on river transport (all operating coast, which are related to transportation, expect for the coast of track facilities, handling);
- on motor transport (all operating coast associated with the carriage of goods and passenger, expect for the costs of maintaining roads);
- on aviation transport (all operating coast associated with the transportation of passengers, airport taxes, fuel and aviation security).

The operating cost constitute the main and additional costs. The main cost include: salaries for drivers, shipmasters, conductors (45%), fuel costs (32%), spare parts (14%), maintenance and repair, equipment depreciation (74%) spare parts wear. Additional costs include: equipment insurance and leasing.

Productivity of labor is determined by the formula:

$$\Pi = \frac{\sum pl}{h_n} \quad (8)$$

where $\sum pl$ – specified tone-kilometers for the year; h_n – the average number of employees per year, which are directly related to transportation.

For example, in road transport this category includes: drivers, mechanics, conductors, engineering, and technical workers, loaders, security guards, medical personnel.

Indicators of technical labor determine the degree of use of technical equipment of transport.

To this group of volumetric indicators can be attributed: the integrated mileage of technology for example for a car – trains-kilometers, for ship – miles. The

number of cargo operations that are performed at the departure points and the number of cargo operations along the route to the destination point, as well as the number of units of the equipment involved are transferred from one transport unit to another [7].

Subgroup of qualitative indicators are: the turnover of the transport unit (car, locomotive, wagon, ship, airplane) in hours and days, average daily mileage in kilometers, hours. Traffic speed, static and dynamic loads of the rolling stock (cars, wagons, ships) – in tones, mileage utilization rate or percentage of cargo mileage of the transport unit to the total mileage for the calculated period and average traffic expectancy per day in hours.

Park utilization factor (percentage working units of equipment) of the total number of productivity units of transport units in ton-kilometers. With the help of these indicators, the quality of the use of rolling stock is estimated for an hour in relation to the declared capacity and utilization.

Important indicators should also include: turnover, average daily mileage, speed of rolling stock. Turnover represents the time spent by the transport unit for the execution of a single transportation cycle. This time is calculated from one load of a unit to the most; during this period, one mobile unit of transport takes part in the primary operation, which includes: loading, transfer from one point of departure to the destination at the end point during which the cargo will be unloaded and transferred to the next loading point.

The basis formula for a finding the turnover of a transport unit is:

$$t_{об} = \frac{l_{об}}{V_{ст}} + t_n + t_a \tag{9}$$

where $l_{об}$ – the total distance of a unit`s displacement for a revolving flight in kilometers and includes the loaded and empty parts; t_n, t_a - time at the loading and unloading station; $V_{ст}$ - average speed per flight in kilometers-hours.

Acceleration of turnover of rolling stock is one of the main tasks for each mode of transport: the shorter the turnaround time, the greater will be the transportation work of the fleet of rolling stock.

The average daily mileage is the number of kilometers, which on average passes each transport unit per day. In general calculations, the average daily run consists of a run in the loaded and empty state, which is calculated using a functional connection with the turnover:

$$L_{добб} = \frac{l_{об}}{t_{об}} = \frac{l_{нав}+l_{пор}}{t_{об}} \tag{10}$$

where $l_{об}$ – full turn-over (full flight) kilometers, which is the amount of a loaded and empty flight ($l_{нав} + l_{пор}$); $l_{нав}$ – turnover per unit per day.

The indicators of the speed of movement of transport units on different types of transport have different specifics of calculation. Four types of speed are considers:

- running, which is realized immediately after the stage of acceleration (relative to aircraft – this speed called cruising speed);
- technical, which is the average speed without taking into account stops at intermediate stations;
- operational or commercial (on the railway – it is called a divisional);
- the average speed of traffic – takes into account stops on the intermediate shoulder at the boundaries of the route section, which is the average speed

of the whole transport movement from it`s formation to disbandment.

In some case the route speed is the same as the speed of delivery.

Static load characterized the quality of use of the carrying capacity of each transport unit on average at the stage of it`s prime load. Comparing the static load with the average load capacity, we can draw the following conclusions that the dynamic load takes into account the run to the destination. The greater the mileage of the full-load units in comparison with the low-load units, the higher the average dynamic load and vice versa [8].

An important indicator of the productivity of a transport unit (car, ship, airplane, wagon) is measured by the number of ton-kilometers or passenger-kilometers per day which average on each unit of the working fleet or on one ton of payload and one linear force of power.

Obviously the higher the average daily mileage and the greater the dynamic load of each transport unit the higher their productivity [9].

A special category is underlined by indicators that characterize the technical level of equipment capacity for each type of transport. This category includes the following indicators:

- length of the network of communication routes (road, rail river and waterways);
- total tonnage of the rolling stock;
- the total energy capacity of the rolling stock (active units);
- the network of operation and repair enterprises (depot maintenance stations, port bases, airfields, terminals, repair plants, docks);
- saturation of operating enterprises equipped with repair equipment);
- automation and mechanization of labor;
- transportation and throughput of different transport objects.

Important indicators of the capacity of any mode of transport is throughput and transportation:

- the throughput is the maximum number of mobile units that can be dropped on a certain object (a section of the path) per unit of time;
- the transport possibility is the maximum amount of cargo, passengers, which can be transported for a calculation period depending on the availability of rolling stock, fuel, personnel and a certain number of transport equipment.

Conclusions: the set of the given indicator`s is an improvement in the work of transport. Considering the need for close interconnection of different modes of transport, it is recommended to introduce the unification of the system of indicators in terms of methodological and terminological terms among their complete comparison. The efficiency of the main transport performance indicators should be incorporated into the national experience of creating a unified system for assessing the performance of all modes of transport. Indicators of the work of transport – a transport paradigm which has all the bases to actively develop in the transport worldview.

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