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APPLICATION OF THE DISCRETE METHOD IN THE PROBLEM OF EFFICIENT DISTRIBUTION OF MOTOR TRANSPORT VEHICLES TO ROUTES

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In the context of increasing global competition, the efficient use of transport systems—namely, the rational selection of transport vehicles and mechanisms, while taking into account the interests of process participants and meeting their needs—remains one of the most urgent tasks. As a factor in reducing the cost price of products and services, the role of the transport system is crucial, since the development of this system, alongside the reduction of transport costs in the production of goods, ensures the competitiveness of the national economy.

Scientific research conducted in the field of managing transportation processes by motor vehicles shows that, depending on the essence of the problem, modeling methods such as **linear programming, discrete programming, dynamic programming, and stochastic linear programming** are applied.

If the problem of freight transportation planning requires the determination of solutions that meet the requirements of an optimality function and constraint equations, then computational schemes and computer algorithms based on linear programming methods are widely used [1, 3, 4, 5, 6, 7].

It is of great importance to conduct research on the technological nature of shippers' and consignees' demand for freight transportation, the satisfaction of this demand, and the management of freight flows based on the efficient allocation of motor transport vehicles (MTVs) to routes. This ensures that the demand for freight volumes is met, the opportunities of shipment (loading/unloading) are fully utilized, and transportation costs are minimized in accordance with selected criteria. From this perspective, in organizing transport-logistics services effectively, it is necessary to use improved models of efficient distribution of motor vehicles to routes.

Consumer destinations (CDs) are served by routes of various lengths. The length of the freight route and the type of cargo transported determine, on the one hand, the number of motor vehicles that can be effectively employed on these routes, and on the other hand, the distribution of a limited fleet of vehicles among the routes defines the number of trips (freight volumes) delivered to or collected from the consignee. The number of MTVs assigned to a particular route cannot be arbitrarily large or small. The number of vehicles allocated to routes should not exceed the loading/unloading capacities of the respective destinations and should ensure their full utilization.

Thus, the problem of distributing a fleet of MTVs to CDs can be formulated as generating and analyzing combinations of different options for efficiently loading a given number of service channels with vehicles during a workday.

Vehicles are distributed to freight routes in such a way that the freight demand of each consumer destination is satisfied. The required freight volumes can be managed not by changing the total number of vehicles, but by redistributing them among different routes. That is, if a consumer destination has a higher demand, more vehicles are allocated to shorter routes, or conversely, if the demand is lower, more vehicles are assigned to longer routes.

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The problem of allocating transport vehicles to freight routes can be formally defined as follows. All routes that deliver goods to a consumer destination are numbered in ascending order of their length, forming a set J. For each cargo type l ∈ L, the subset Jl ⊆ J is defined as the set of routes used to transport that type of cargo. For each Jl, the required daily freight volume Zl is given as the number of trips.

The number of trips Zj planned for each route j is restricted to discrete values, which depend on the number of mechanisms and channels available at the point of departure for loading vehicles. Suppose the set Σj = {0,1,…σj…σjmax} defines the number of mechanisms available for loading vehicles at route j (j ∈ Jl). If the productivity of one mechanism is γ trips per day, then the possible number of trips on route j can be expressed as:

$$Zl = \{0\cdot\gamma,\ 1\cdot\gamma,\ 2\cdot\gamma,\ \ldots,\ \sigma jmax\cdot\gamma\}.$$

This problem has its own specific properties, and the solution method must be designed based on these features.

If a combination of trips Zj (j ∈ Jl) satisfies the required demand Zl for a consumer destination, such a combination is called a feasible set of trips.

For a feasible set of trips satisfying the demands of consumer destinations, the following condition must be fulfilled:

(1) $$\sum_{j \; J_l} Z_{j\sigma_j} = Z_l, \qquad \sigma_j \qquad j \; .$$

This ensures that the volume of freight delivered to the destination is exactly equal to the required demand Zl. In addition, another condition of efficient vehicle usage must also be met, namely, the degree of vehicle workload during the day must remain within the specified interval (Aeff)min ÷ (Aeff)max:

(2) $$(A_э T_H)_{\min} \qquad \sum_{j \; J} Z_{j\sigma_j} \; t_j \qquad (A_э T_H)_{\max}, \qquad \sigma_j \qquad j$$

Thus, the problem can be solved by enumerating all possible sets of trips Zj and checking for each whether conditions (1) and (2) are satisfied. The solution algorithm consists of the following blocks (see Figure 1):

1. For each cargo type **L** in the given set of cargo types, form the possible combinations of trips.

↓

2. $Z_{j\sigma_j}$ From the possible combinations of trips, determine the combinations ($Z_{j\sigma_j}$) of vehicle trips that satisfy the **TM** Z_l volume requirement.

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3. For each cargo type **L**, ($Z_{j\sigma_j}$) form the possible combinations of trip sets that meet the required demand.

↓

4. (Z_l) Among the possible combinations of trip sets that meet the demand, identify those combinations that ensure the daily load factor of the vehicle fleet (YuDTB).

Figure 1. Blocks of forming the feasible set of trips satisfying the demand Zl of consumer destinations.

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