# Information parameters of transport technology for choosing the optimal car route

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**Abstract.** In modern society are widely used innovative technologies in transport management. It is known that a significant part of the cargo turnover is carried out by road transport. Therefore, the use of various digital and information methods that ensure high productivity and cost-effectiveness of cargo delivery is highly relevant. Increasing the share of transportation costs in the total cost of goods produced using methods of logistic analysis to improve the efficiency of freight traffic. A significant role in this process is played by modern innovative technologies that make it possible to monitor the conditions of the transport process and select the optimal option for cargo delivery.

The use of navigation equipment, as a component of an integrated control technology, makes it possible to select the route of movement with the shortest length. In some cases, it is possible to determine the route with the shortest duration of movement, based on the average values of the speeds of the rolling stock and the average time of delays when passing through settlements.

Analysis of existing methods for determining rational routes shows their imperfection, which can be the reason for a decrease in the efficiency of transportation. The minimum length of the route does not guarantee timely delivery of the cargo, since in this case a number of significant factors of the transportation process are not taken into account. First of all, the condition of the road surface is not taken into account, which determines the average technical speed and the probability of delays on the way. Travel time is determined without taking into account the operational properties of the vehicle and the capacity of roads and road structures. As a result, the data obtained using modern innovative technologies can lead to significant errors in assessing the indicators of the transport process.

In addition, obtaining a rational route does not mean the fulfillment of specified performance indicators for a number of reasons. First of all, the fulfillment of the production task can be ensured when the vehicle is in good condition throughout the entire route of receipt and delivery of the cargo. This condition can be provided with reliable forecasting of the resource and the level of reliability of the vehicle [1].

The driver's readiness to carry out transport work is equally important. Non-compliance with the specified requirements may cause disruption of the transport process and affect

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traffic safety [2]. Therefore, the ability to monitor the condition of the driver, provided by control technology, is an important factor in the implementation of the production process.

It is necessary to take into account the features of the operation of road transport's rolling stock in several regions of the temperate, subarctic and arctic zones. As the experience of operating trucks [3] shows, low temperature and mobility of atmospheric air is a frequent cause of malfunctions and failures on the way, which affects the timeliness of delivery and safety of the cargo.

A systematic approach to organizing the information flow of technological means of traffic control makes it possible to establish important constituent elements of transportation efficiency. Significant factors of the natural-technical system "control center - car - driver - environment" determine with a high probability the operational parameters of the transport process of intercity freight traffic. The control of the operational state of transportation can be carried out through the use of a set of estimated indicators in the innovative technology, which takes into account the mutual influence of communication routes, participants in the transport process and natural and climatic conditions.

Consider the importance of taking into account inter-element connections in the proposed system by the example of ensuring safe movement and maintaining the serviceable state of a car through the use of a traction control system. The rational distribution of power in an automobile transmission is a difficult task, the complexity of which is determined by a large number of influencing factors and the limited choice of characteristics of the distribution unit for design and cost reasons. The solution of the problem should be preceded by the ranking of the information system of the technology for controlling external factors according to the degree of their influence on the operational properties of the vehicle and the choice of estimated indicators that determine the distribution of power in conditions of movement along a given route.

This task is partially performed by the traction control system, anti-slip regulation and anti-lock braking systems, the programmed control of which is set by certain criteria. However, the capabilities of existing systems are limited by the registered information space and the number of control criteria. Therefore, the choice of rational values of traction and braking forces on the wheels does not always correspond to real operating conditions. A theoretical and experimental analysis of the objective parameters of the information space is necessary, in addition, in choosing modes of operation and maintenance of electronic control systems for the engine and automatic transmission [4].

The information space of traction control systems, traction control and anti-lock braking systems is determined by external and internal objects of influence, each of which can be characterized by a rational number of parameters. It is also necessary to take into account inter-object influences, the influence of which may require correction of the information space. In this case, it's a question of the influence of other participants in the transport process, whose behavior and number determine the practical throughput of roads and road structures.

The impacts from the driver's side, the loading unit (power unit) and natural and climatic conditions must be attributed to the inter-element and intra-element connections of the "control center - car - driver - environment" system. The principles of building a private control system designed to optimize the operation of the transmission were given in [5]. Below are the parameters that determine the information space of the system for ensuring safe movement and maintaining the serviceable state of the vehicle.

Vehicle parameters are: speed, axle load distribution, acceleration, torque and engine crankshaft speed, transmission ratios, engine turbocharging presence and pressure, torque converter operating mode for hydromechanical, variator - for continuously variable mechanical transmission, presence and braking mode car, tire pressure, turning radius, gear ratios of differential mechanisms, rolling radii of driving wheels, tangential elasticity of tires, kinematic mismatch in the drive, temperature of actuators (friction couplings), degree of wear of working surfaces of friction couplings, pressure on working surfaces of friction couplings, the presence and absolute value of the circulating moments in the transmission, traction force on the hook or fifth wheel coupling, dynamic deformation of the elastic suspension element.

Communication parameters are: road surface condition, degree of deformability of the supporting surface, presence of macro-unevenness, relative wheel slip, coefficient of adhesion of the driving wheels to the supporting surface, ascent (descent) angle of the vehicle, bend angle, throughput;

Environmental parameters are: aerodynamic components of the total (overall) force of resistance to motion (lift and lateral forces, aerodynamic moments), angles of inflow and attack, temperature and mobility of atmospheric air, the presence of precipitation (rain, snow);

Parameters common to all elements of the system are: duration, nature and amplitude of exposure.

A systematic analysis of these parameters for various types of trucks has not been carried out yet. Such a study imposes certain restrictions on the possible implementation of torques on the wheels from the side of the necessary criteria for ensuring the car controllability and stability.

The complexity of the distribution of traction and braking moments according to the safety criteria for cornering is that a quick change in the moments only according to the criteria of the difference in angular velocities can lead to a significant change in steering, and a slow change in the moments can be ineffective and lead to wheel slip. In addition, the distribution intensity should be related to the specific route, traffic capacity and road surface properties that may be additionally influenced by the external environment. The work [5] indicates the relationship between the coefficient of wheel adhesion and the possibility of an emergency, which is set by the accident rate. It also noted the danger areas marked by the coincidence of the total aerodynamic force and the resulting centrifugal force acting on the vehicle when maneuvering. A significant change in the efficiency of traction control systems, anti-slip regulation and anti-lock braking systems, depending on the design features and loading, is possible. For example, increased transmission sensitivity can cause a significant change in vehicle steering when cornering slippery. Such dangerous situations are effectively monitored in the proposed information space of the traffic control technology.

Based on the study of the links of the technical system "control center - car - driver - environment", it is proposed to use the following objective function to control the transport process:

$$\Lambda_t = \sum_{i=1}^{4} \left( \gamma_i \cdot N_i \right) = \gamma_1 \cdot S_e + \gamma_2 \cdot H_j + \gamma_3 \cdot L_x + \gamma_4 \cdot E_w \cdot \quad (1)$$

where $N_i$ - the estimated indicators of the system links taken into account; $\gamma_i$ - coefficients of the objective function; $S_e$ - indicator of the rationality of the route of the vehicle in terms of its length and the presence of delays along the way; $H_j$ - indicator of the rationality of the route of movement of the vehicle according to the practical throughput of road sections and road structures along the route; $L_x$ - an indicator of the rationality of using a vehicle for the minimum residual resource of chassis systems and assemblies; $E_w$ - an indicator of the rationality of the use of a vehicle in terms of maintaining the normal range of functioning of systems and chassis assemblies in cold or hot climates.

The choice of the vehicle route should be carried out taking into account the real state of the road network, information about the possibility of travel and the average time spent on bypassing large settlements and industrial centers. Such information is presented in the public domain [6]. It is necessary to take into account that the real speed of movement of vehicles in modern conditions has increased significantly, which requires adjustments to the generally accepted methods for determining the productivity and economic efficiency of freight traffic [7].

The determination of the practical carrying capacity of road sections and road structures should be carried out according to the method described in [8], taking into account the known parameters of roads and road structures. It is necessary to take into consideration the geometric parameters of the roads, the composition and intensity of the traffic flow, the traffic conditions (the presence of speed limits, the types of intersections with other communication routes, etc.), the presence and condition of road markings. For road structures, their dimensions are taken into account, which determine the possibility of movement on the carriageway. Estimating throughput within settlements should take into account the overall length of streets, additional restrictions caused by the presence of pedestrian crossings, parking areas and the state of the right-of-way.

The rationality of using a vehicle for the minimum residual resource should be assessed according to the data analysis of information on-board systems for diagnosing the technical condition of automotive units and systems [9-11]. Elimination of a possible refusal on the line makes it possible to increase the stability of the average technical speed and time of cargo delivery.

The use of a vehicle in cold or hot climates also makes adjustments to the operation of control technology. Here it is necessary to take into account both the technical condition of the vehicle under the influence of extreme natural and climatic conditions [3], and the operational condition of the roads in such conditions. Information about the temperature and mobility of atmospheric air, temperatures of parts and lubricants is important for determining the level of reliability of units and ensuring the efficiency of transportation.

The described information space of the digital technology of transport process control makes it possible to implement continuous monitoring of the material flow in the logistics system. The effectiveness of innovative technology can be significantly increased by including in the unified control system of private subsystems responsible for the technical condition of the vehicle, control of the throughput of communication routes and natural and climatic conditions of movement.

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