# Matematical models for assessing the quality of functioning of the motor transport company

Giorgi Iakobidze, Giorgi Purtskhvanidze, Vladimer Gvetadze, Aleksandre Kamladze,
Akaki Tsereteli State University, Kutaisi, Georgia
iakobidze.giorgi92@gmail.com, Giorgi.purtskhvanidze@atsu.edu.ge , Vladimer.gvetadze@atseu.edu.ge, Aleksandre.kamladze @atseu.edu.ge,

***Abstract.*** *In order to obtain the methods of assessing the quality of the functioning of the motor transport company, it is necessary to develop a methodology for quantitative evaluation of this quality. This methodology should be based on mathematical models of the quality of operations of the motor transport firm.*

*For purposeful formation of quality, the paper proposes an adequate method of analysis of this quality. At the same time, a method of evaluating the quality of the functioning of the automobile enterprise, evaluating the quality of the decisions taken to improve this property, and forecasting the expected quality of the functioning have been developed.*

**KEYWORDS**: *TRANSPORT FIRM, PRODUCT, QUALITY, SERVICE, EVOLUTION, MATHEMATICAL MODEL.*

## *1. Introduction.*

The development of a methodology for assessing the quality of the functioning of a motor transport enterprise is carried out on the basis of methods for the formation of composition, structure, properties and target vectors [1. 2].

In the process of activity of a motor transport company, it is necessary to form optimal values of indicators characterizing their work. The complex of these indicators, in a certain sense, should be perceived as a planned task. At the same time, the costs of the enterprise to maintain these planned indicators should be minimal.

Thus, it is necessary to be able to make a deliberate choice of the most effective solutions to improve the operation of the motor transport enterprise. In the case when it is necessary to predict the quality of operation of the motor transport enterprise, it is necessary to take as target parameters the parameters obtained by the method of determining the predictive values of the target vectors [3. 4].

Based on the theoretical studies conducted, which are presented in the work [1], we can specify that, depending on the purpose of the analysis, individual motor transport enterprises or their structural subdivisions (the driving schools, drivers' brigades, maintenance teams, etc.) can act as elements.

The parameters of goals and state vectors depending on the system property, structure and composition will be discussed as a disorder situation.

## *2. Mathematical modeling.*

Generalization by time interval means that disorganization is generalized into intervals (decade, month, year, etc.) over a time period divided into intervals [5].

In line with this reasoning, the target entropy model ($H_m$) and its maximum value ($H_{max}$) will take the following form for evaluating the disorganization of the vehicle fleet's operation:

$$H_m = \sum_{i=1}^{I}\sum_{j=1}^{J}\sum_{c=1}^{C} P_{ijc} \cdot ln(q_{ijc} - \varepsilon(X_{ijc})w_{ijc} + 1) \quad (1)$$

$$H_{max} = ln\{(\prod_{i=1}^{I}\prod_{j=1}^{J} max(Q_{ijc} - \varepsilon(x_{ijc})) \cdot \omega_{ijc} + 1)\}, \quad (2)$$

where I, J, C – respectively, the numbers of elements, goal parameters and time intervals according to which system entropy is generalized;

$P_{ijc}$ - the probability of disagreement;

$q_{ijc}$ – the modulus of disagreement vector;

$\varepsilon(x_{ijc})$ - the boundary of an almost orderly zone;

$w_{ijc}$ – Boolean variable.

The purpose of Boolean variable is to reduce to zero the value of the disorder parameter and, as a result, the value of the entropy, *if* $q_{ijc} - \xi(X_{ijc}) < 0$.

In accordance with expressions (1) and (2), the organization of the institution's functioning in relation to the parameters of composition ($Q_{com}$), structure ($Q_{str}$) and property ($Q_{pr}$) will be as follows:

$$O_{com} = 1 - \frac{\sum_{i=1}^{I}\sum_{n=1}^{N}\sum_{c=1}^{C} P_{inc} \cdot ln(q_{inc} - \varepsilon(X_{inc})\omega_{inc} + 1)}{ln\{(\prod_{i=1}^{I}\prod_{n=1}^{N} max(Q_{inc} - \varepsilon(x_{inc})) \cdot \omega_{inc} + 1)\}}, \quad (3)$$

where N – the composition vector parameter.

$$O_{srt} = 1 - \frac{\sum_{i=1}^{I}\sum_{m=1}^{M}\sum_{c=1}^{C} P_{imc} \cdot \ln(q_{imc} - \varepsilon(X_{imc})\omega_{imc} + 1)}{\ln\{(\prod_{i=1}^{I}\prod_{m=1}^{M} \max(Q_{imc} - \varepsilon(x_{imc})) \cdot \omega_{imc} + 1)\}}, \quad (4)$$

where M - the structure vector parameter.

$$O_{pr} = 1 - \frac{\sum_{i=1}^{I}\sum_{\bar{c}=1}^{\bar{C}}\sum_{c=1}^{C} P_{i\bar{c}c} \cdot \ln(q_{i\bar{c}c} - \varepsilon(X_{i\bar{c}c})\omega_{i\bar{c}c} + 1)}{\ln\{(\prod_{i=1}^{I}\prod_{\bar{c}=1}^{\bar{C}} \max(Q_{i\bar{c}c} - \varepsilon(x_{i\bar{c}c})) \cdot \omega_{i\bar{c}c} + 1)\}}, \quad (5)$$

where $\bar{c}$ - the structure vector parameter.

In the general case, the quality level of the system functioning can be characterized by any point inside the space limited by a unit cube (Fig. 1). In this case, the formation of the highest level of system functioning quality consists in the choice of options for the decisions for the purposeful transfer of the system to the point Oo.

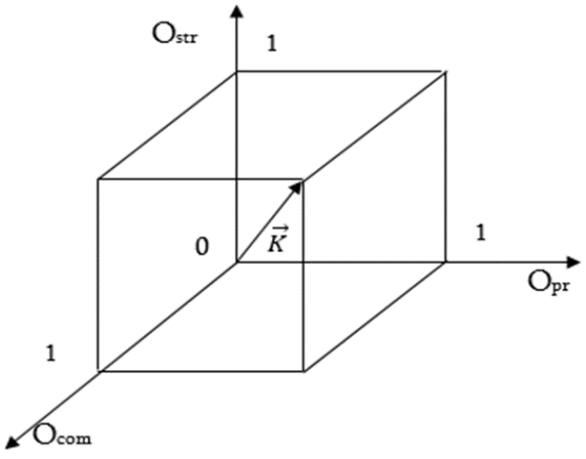


***Fig. 1.*** *A geometrical interpretation of the quality of the system's functioning*

From the expressions (3), (4) and (5), taking into account the picture 1, the vector K is determined as follows

$$\bar{K} = \sqrt{O_{com}^2 + O_{str}^2 + O_{pr}^2} \quad (6)$$

It should be noted that that the parameters of the target vectors, depending on the choice of the method of justifying the benchmark or target values, the interpretation of these estimates will have its own characteristics.

As we have already mentioned, an adequate system of analysis is required for the purposeful formation of the quality of functioning in the context of the transition economy, which characterizes the dynamic capabilities of the institution.

Adequacy of the analysis to modern management conditions is determined by the subject and purpose of the given analysis.

The subject of the analysis is the quality of the functioning of the vehicle fleet and its subdivisions.

The purpose of the analysis of the quality of operation of a fleet is to reveal and assess the degree to which these properties are exhibited in the operation process.

The objectives that determine the content of the analysis are as follows:

- to assess the use of the existing reserves for improving the quality of the vehicle fleet operation;
- to reveal the possibilities of system improvement and assess the effectiveness of actions taken;
- to forecast expected results of the quality of functioning.

The assessment of the quality of using the existing reserves for the improvement of the quality of the operation of the vehicle fleet can be made based on an in-depth analysis of the organization of the operation in relation to the parameters of the composition, structure and properties of the vehicle fleet.

The organization of the system's functioning in relation to the composition is expressed by a vector, whose parameters are indicators such as the average number of vehicles, average load capacity, number of employees, number of drivers, average yearly cost of basic production assets and so on. This vector characterizes the composition of the institution. If the parameters of this vector hardly change during the period of analysis, for example during the year, then the organization of functioning in relation to the composition of the institution will be close to one. In relation to the composition, the organization of the functioning will not be affected either by the human factor at the level of technology or by the surrounding environment in the short term.

At the same time, the organization of functionality in relation to the structure is formed not only by the influence of the parameters of the composition vector, but also by the human factor at the level of technology. This is the organization of processes within the institution, and the parameters of the characteristic structure vector of these processes can be the technical readiness coefficient, average salary, total costs, variable costs and so on.

The organization of the functioning in relation to the properties of the system is formed by the disturbing influence of the surrounding environment in addition to these two vectors. The parameters of the property vector can be the time spent on duty, the operating speed, the income and so on. Thus, the organization of functioning in relation to the composition of the system is considered as a potential basis for the ability to adapt to the environment.

The same consideration applies to the organization of the functioning in relation to structure.

At the same time, it is necessary to note that the organization of functioning in relation to the composition will be higher than the organization in relation to the structure, because the human factor takes part in the formation of this organization. This circumstance will lead to scattering the results obtained in relation to the given objectives. Confusion about the properties of the system will further increase because disturbing effects of the surrounding environment will begin to emerge.

In order to identify the reserves for increasing the confidence in the quality of the operation of the vehicle fleet, it is necessary to determine the degree of influence of the human factor and the environment on the organization of the operation, so let us find out how many times the organization of the fleet's functioning has deteriorated in relation to the structure and properties in relation to the composition. Quantitatively, this can be expressed by the following coefficients:

$$K_1 = O_{com}/O_{str} \quad (7)$$

$$K_2 = O_{com}/O_{pr} \quad (8)$$

$$K_3 = O_{str}/O_{pr}\ , \quad (9)$$

where $K_1$ characterizes the influence of the human factor on the functioning of a fleet; $K_2$ characterizes the joint influence on the organization, the influence of both the human factor and environmental factors; $K_3$ characterizes the influence of the surrounding factor on the organization of the fleet's functioning.

All three ratios must be greater than or equal to one.

In the borderline case, when they are equal to one, it means that the quality of operation of the vehicle fleet is the highest, and the greater the difference of the values of these coefficients from one, the lower the quality of operation. The problem of identifying opportunities for improving the operation of the vehicle fleet and assessing the effectiveness of the decisions is that the results should allow solving specific practical tasks. In the process of operation of the vehicle fleet, it is necessary to form the optimal values of indicators that characterize their operation. The set of these indicators should be taken as a planning task in a certain sense. In addition, the institution's expenses for maintaining these planned indicators should be minimal.

Thus, it is necessary to realize the possibilities of a purposeful choice of more efficient solutions in order to improve the functioning of a fleet. Forecasting the expected results of the quality of the functioning of the vehicle fleet, in the case when there is a need to predict the quality of the functioning of the vehicle fleet, it is necessary to take as the target parameters the parameters obtained by the method of determining the predictive values of the target vectors, and then, according to the expressions (5), (6), (7), (8) and (9), the value of the $\overline{K}$vector is determined, which characterizes the quality of the vehicle fleet's functioning.

## *3. Conclusions.*

Thus, for the purposeful formation of the quality of functioning, an adequate methodology for the analysis of this property is proposed. In addition, the methods of assessing the effectiveness of actions taken in order to increase the quality of the fleet's functioning and forecasting the expected quality of functioning have been developed.

## *4. References*

1. Giorgi Purtskhvanidze, Mikheil Lejava , Zaza Shubladze, Giorgi Iakobidze. Methods and theoretical foundations for assessing the quality of products and services of a transport firm. INTERNATIONAL SCIENTIFIC JOURNAL INNOVATIONS YEAR XI, ISSUE 1 / 2023.- 14-17 p.
2. I. Dangadze, G. Purtskhvanidze, G. Arjevanidze. Selection of the location of logistics infrastructure elements based on an infinite number of options. Proceedings of the International Scientific-Practical Conference "Modern Science and Innovative Practice". Volume 2. 2018.- 221-224 p. ISBN 978-9941-484-05-6. ISBN 978-9941-484-07-0.
3. Andronov I.V., Klochkov V.N. Theoretical prerequisites for the formation of a system of indicators of the quality of the functioning of motor transport systems // Actual problems of economics and transport: Sat. scientific tr. -Saratov: SGTU, 2001.-p. 65-68.
4. Evseeva A.A., Andronov I.V. On the issue of organizational and economic sustainability of the enterprise // Organization of international and domestic transportation using the principles of logistics: Sat. scientific tr.- SPb., SPbGIEU, 2001.-p.75-77.
5. Lukinskiy B.C. Road transport logistics: concept, methods, models / B.C. Lukinsky, V.I. Berezhnoy, E.V. Berezhnaya and others - M .: Finance and statistics, 2000.-280 p.