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FUZZY OPTIMIZATION OF TRANSPORT LOGISTICS TASKS

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Abstract- Most real-world optimization problems and management of transportation processes involved need to address them in a certain degree of uncertainty. The present study is an analysis method for determining transport in fuzzy environment. Classical mathematics cannot effectively solve a number of problems due to the vehicle, it cannot take into account the uncertainty. Therefore, automated management now requires new methods and models for the development and management decisions. It should be noted that the article properly evaluated the necessity of combining approaches, deterministic and probabilistic methods of fuzzy logic to the interconnected problems with characteristics of logistics vehicles. Among the most significant scientific results obtained, include generalized and developed theoretical and computational foundations of the trucking logistics to ensure account factors of uncertainty and randomness. The proposed models and methods provide a solution based on a number of approaches using quality criteria, applying the theory of fuzzy logic state of the environment, uncertainty of conditions of road transport.

Keywords: Fuzzy Logic, Transport Process, Method of Logistics, Uncertainty.

I. INTRODUCTION

Beginning of the modern theory of fuzzy set at the 1965 American scientist, professor at the University of Berkeley (California, USA), Azeri origin L.A. Zadeh. The concept of fuzzy sets in the sense J.I. Zadeh, ushered in a new momentum in the field of mathematical and applied research. To the extent that in the short term have been proposed fuzzy generalization of basic set-theoretical and formal-logical concepts. The theory of fuzzy logic and fuzzy approach to the modeling of complex systems has been recognized around the world.

The most notable work in this area should be noted publications T. Zadeh, D. Dubois and A. Prada on the theory of fuzzy measures and opportunities M. Sugeno, by Mamdani fuzzy inference and fuzzy integral, J. Bezhdska on fuzzy clustering and pattern recognition, R. Jager, R. Aliev, V. Pedrich, B. Turks, S. Ulyanov, M. Jamshidi on fuzzy logic, and others. The mathematical basis of fuzzy and hybrid systems are opposed to traditional computing (hard computing), the so-called soft computing (soft computing), a component of which is a fuzzy logic.

Recently, fuzzy control is one of the most active areas of research and effective application of the theory of fuzzy sets. This is what makes subject relevant and interesting to explore. Methods of the theory of fuzzy sets are used for different purposes. Three stages of development. The first of them specialists for the synthesis of control algorithms using the classical methods of control theory and created a device with a double-digit (clear) logic, based on the elements of hydraulic and pneumatic.

However, devices, operating on a "ban-resolution", denied prompt reprogramming, i.e. even forced them to adapt to changing conditions. In the second phase appeared microprocessor control with programmable electronic components. Computer equipment, on-board computers and microcomputers allowed to enter into their memories are different programs, to some extent, the ability to adapt (adapt) to changes in road and other conditions. In the third, the present, the stage for the simultaneous consideration of the huge variety of information, different circumstances and situations, characteristics of control by the driver, the environment, and the mechanisms of the vehicle began to form intelligent control systems.

They are based on fuzzy logic algorithm is similar to the processes of human thinking. This is the adaptive system in the classical sense. Despite the fact that the fuzzy logic appeared relatively recently, it has already established itself as a relatively simple, reliable and fast theoretical mechanism to increase degree of automation of the car due to the implementation of the principles that cannot be treated the classical two-valued logic.

II. IMPLEMENTATION OF TRANSPORT MANAGEMENT ELEMENTS OF FUZZY LOGIC

In view of the above we can safely say, one of the world's automotive industry trend is the introduction to the control elements of fuzzy logic. Despite the fact that the fuzzy logic appeared relatively recently, it has already established itself as a relatively simple, reliable and fast theoretical mechanism to increase degree of automation of the car due to the implementation of the principles that cannot be treated the classical two-valued logic.

Great achievements today are characterized by transport logistics. She is one of the most serious, complex, important blocks of common sourcing, has recently attracted more and more attention of different companies in a given volume of vehicles using the services for their core business. Elements of the theory of fuzzy sets have

been successfully used in decision-making under uncertainty. There are many studies on decision-making based on fuzzy sets. These studies examined the possibility of using fuzzy set theory, describes the different types of uncertainty. Based on fuzzy sets made decisions, such as:
1- Multi-criteria selection method maxi-mine fold in bank lending.
2- The choice of a competitive product and vehicles using fuzzy preference relations.
3- Fuzzy inference in the problem by selecting a candidate for the vacant position of a specialist.
4- Comparative analysis of different methods of decision-making, etc.

Adaptive control of robots and weapons systems, a highly profitable game in almost all financial markets, intelligent vacuum cleaners, cameras and sewing machines, a track record of success of fuzzy logic grew like a snowball. Currently, the theory of fuzzy methods are used in almost all application areas, including the management of the company, the quality of products and production processes. The most striking feature of human intelligence is the ability to make the right decisions in an environment of incomplete and fuzzy information.

According to this theory, published thousands of books and articles published by several international journals, made a lot of both theoretical and applied work. Actually blurring can be the key to understanding a person's ability to cope with problems that are too complex to solve on a computer world of fuzzy logic is expanding every year. Fuzzy control is one of the most active areas of research and effective application of the theory of fuzzy sets. This is what makes the subject relevant and interesting to explore. The foregoing reflects well the following list of works related to decision-making method based on the theory of fuzzy sets.

Few realize how tangible assistance may have methods of fuzzy logic in control. In view of the above studies, the following conclusions. Fuzzy control is particularly useful when the processes are too complex for analysis by conventional quantitative techniques or when the available sources of information are interpreted qualitatively, inaccurate or vague. Experimentally shown that fuzzy control gives better results as compared to conventional control algorithms.

Fuzzy techniques are helping to drive and train speech recognition and image design robots that have the sense of touch and vision. Fuzzy logic, which is based on fuzzy control is closer in spirit to human thinking and natural language than traditional logical systems. Fuzzy logic, mainly provides effective means of displaying uncertainty and imprecision of the real world. Availability of mathematical tools reflect fuzzy initial information allows us to construct a model that is adequate reality.

The analysis of fuzzy decision-making methods allows us to formulate the requirements for further developments in this area. This development of theoretical approaches to the description of complex relationship between the criteria, greater use of intelligent methods based on fuzzy logic, as well as the development of combined methods of decision making using fuzzy concepts.

By analyzing the situation of road transport in the overall transport structure of domestic and foreign economy, it should be noted that in the near future, the main development trends are expressed in improving the quality of transport and traffic based on modern equipment and technology. This is primarily due to the versatility of transport designed to be most appropriate to requirements of customers, both individual and social. Carrying more than half of the volume of freight and passenger transport, road transport implements its main advantage, the delivery of goods and passengers on a "door to door".

At present, the stage for the simultaneous consideration of the huge variety of information, different circumstances and situations, characteristics of control by the driver, the environment, and the mechanisms of the vehicle began to form intelligent control systems. They are based on fuzzy logic algorithm is similar to the processes of human thinking. This is the adaptive system in the classical sense. Solving the problem of uncertainty in the number of papers devoted to transportation.

For example, in states that the fuzzy control is particularly useful when the processes are too complex for analysis by conventional quantitative techniques or when the available sources of information are interpreted qualitatively, inaccurate or vague. Experimentally shown that fuzzy control gives better results than those obtained with conventional control algorithms. Fuzzy techniques help manage blast furnace and rolling mill, car and train speech recognition and image design robots that have the sense of touch and vision.

Fuzzy logic, mainly provides effective means of displaying uncertainty and imprecision of the real world. Availability of mathematical tools reflect fuzzy initial information allows us to construct a model that is adequate reality. Logistics is a classic example of a systemic product to transport problems. Sophisticated approach to the operation of road transport in the building indicates that the goals associated with a decrease in the time and cost of construction can be achieved by taking into account the relationship and interdependence of major transport and construction operations.

In the logistics system to evaluate the costs and level of service, with the unconditional fulfillment of the requirements of consumption. In other words, the decision on the mode of transport and the type of vehicle is taken with all elements of the transport process, kitting, packaging, warehousing, tip, so that the system has been optimized as a whole and not just one of a systems. The general principle of the concept of a systems approach is that you cannot focus on individual variables. Need to examine their interaction in general.

Therefore, the goal of logistics is to use effectively the system as a whole, not the individual parts. Logistic approach to the management of motor processes requires the integration of individual members of the logistics process in a single system that can deliver quickly and cost-effectively the necessary goods to the right place.

III. THE METHOD OF CHOOSING THE RATIONAL VEHICLE FROM A SET OF ALTERNATIVES

Most real-world optimization problems and of transportation process due to need to address them in some degree of uncertainty due to following problems:

- Impossible or impractical (for reasons of technical and economic) to obtain sufficient amounts of information, the degree of certainty.
- Inability to formalize a number of factors and criteria necessary accounting via information.
- The significant role of the "human factor" in making decisions.

The formalization of the uncertainty factor in the formation of mathematical models of systems and processes considered in [1-3], and other works of the author, provide a means of improving the adequacy of these models and, therefore, the validity and effectiveness of the actual decisions based on them. Solution to the complex problem of optimization of the transport process is associated with a serial execution of a large complex manufacturing operation, efficiency, and quality is most direct impact on improving operational and economic performance of vehicles and businesses in general.

We solve complex problems of road transport process: the choice of effective exchanges and methods of transportation, using a variety of factors preferences. In [1] the solution of the problem of choosing efficient PBX features to make from a set of alternatives based on information (X, R_1, …, R_m), which has the best possible grades in all factors.

$$\mu_{w_1}(x,y)=\sum_{j=1}^{M} a_j \mu_j(x,y) \tag{1}$$

where, X is many alternatives ATC, R_j is preference relation to the jth factor, m is number of factors on which the choice is made ATC.

Choosing an effective PBX on many factors produced using an existing set of preferences in a generalized form presented convolution. Using this ensure optimization of the transportation planning process in terms of fuzzy decision-making minimize method allows for the rational selection of ATS for each considered haul delivery kits.

Therefore, making a good timetable vehicle from the point of such criteria as, the choice of optimal brand, empty runs and excessive downtime in strict compliance with the specified time interval delivery that meets many of the limitations associated with the transportation of goods process is a difficult task. To solve the problem, the proposed method of transportation process in its particular organization recreated on a computer in the form of a simulation model of the network queuing systems.

Problem of decision-making in content can be formulated in [2] as follows. There are many options to choose the type, grade PBX on local criteria, summarized in the multiplicative convolution.

$$KR_i=\sum_{j=1}^{m} K_{ij} L_j \quad \text{or} \quad KR_i=\prod_{j=1}^{m} K_{ij} L_j \tag{2}$$

where, K_j is local criteria, lj is coefficients of the importance of criteria weights, i.e. implementation of each alternative, gives rise to outcomes on a set of performance indicators that uniquely characterize alternative.

Prostrate model requires selection of an alternative, the best in a particular sense that is, satisfying the constraints of the problem and is a way to achieve the goal. Model of decision-making process includes evaluation of ATS, a description of the decision process. Each PBX can be described using quality criteria KR_i, i = 1, n. Ideal PBX points ATP: max capacity utilization PBX minimal empty mileage and minimum excess simple exchange. Ideal ATS in terms of the construction company (C), adherence to the specified delivery schedule with minimal empty mileage and maximizing load vehicle. The ratio is useful to evaluate alternatives in the Table 1. The utility values of alternatives in a simplified form is shown in Table 2.

Table 1. The ratio to evaluate alternatives

Optimum grade (max. use carrying capacity) ATC max γ_c	Optimal ATC min empty runs ATC min l_{nop}	loading ATC expectation t_A^o	waiting for unloading stations t_{np}^o
A very important	Important	important	Not very important
A very important	A very important	important	A very important
pretty important	pretty important	A very important	A very important

Table 2. Utility values of alternatives in a simplified form

Alternative motor vehicle	Transport Company	builder
A_1	very high	Is not very high
A_2	The rather high	very high
A_3	Average	The rather high

Based on these features, we can conclude that the best alternative is A_2 (with maximum capacity utilization, minimal empty mileage, with negligible latency excess ATC points of handling and a high level of compliance with the delivery schedule). This result was obtained by the Equation (3).

$$\mu_{AC}(\alpha)=\min(\mu_A(KR),\mu_C(KR)) \tag{3}$$

where, A is transport company, C is builder, KR is criterion. Using this method allows for a rational set of PBX for each considered haul delivery kits, and, therefore, ensure optimization of the transportation planning process in terms of fuzzy decision-making.

IV. MODEL FOR SOLVING THE PROBLEM OF ROUTING TRAFFIC

Transportation planning is based largely on the experience of the control room, which is currently not able to properly cope with this problem, because of the increasing volume of traffic, and complicating conditions. Efficient use of motor vehicles is improved transport organization with the help of mathematical methods for solving problems. Solution of routing traffic in general, as connected with great difficulties because of the need to take into account a number of factors that have a random variable, in some degree related to the uncertainty in Tew. The formalization will serve as a means of increasing uncertainty adequacy calculations generate the real conditions of operation of the PBX.

The most important task of traffic management on the route is the maximum acceleration of the rolling stock turnover. To increase the efficiency of the transport process factors include: the right choice PBX, sensitive cargo and providing high dynamic qualities, rational distribution of vehicle routes, reducing waiting time and perform loading and unloading operations, the need for proper and precise performance of vehicle, the organization of the transport process.

Decision-makers in road transport are often faced with the problem of the distribution of vehicles of varying load on the routes of different lengths. Solution of the problem [3] can be two ways of distribution, A and B:

- In option A, PBX with larger capacity is directed to the route with a longer turnover and exchange with smaller capacity on routes with shorter turn-in option B, PBX with larger capacity is directed to the route with the shorter turnover and exchange with less capacity on the route with a longer turnover [6, 7].

It should be noted that could not determine the preferred option. You want to compare the production of vehicle T hours on volume of cargo and transportation purposes routes using different criteria. Comparison of options for the development of ATS criteria, In terms of traffic and transport, work done after simple algebraic manipulations can be summarized as follows:

- In terms of traffic:

$$\frac{q_{H_1} v_{t_1}}{q_{H_2} v_{t_1}} * \frac{(l_{o_1} + v_{t1} t_{n-p_1})(l_{o_2} + v_{t_1} t_{n-p_1})}{(l_{o_1} + v_{t2} t_{n-p2})(l_{o_2} + v_{t_2} t_{n-p2})} \tag{4}$$

- Upon fulfillment of the transport operation:

$$\frac{q_{H_1} v^2{}_{t_1}}{q_{H_2} v^2{}_{t_1}} * \frac{(l_{o_1} + v_{t_1} t_{n-p_1})(l_{o_2} + v_{t_1} t_{n-p_1})}{(l_{o_1} + v_{t_2} t_{n-p2})(l_{o_2} + v_{t_2} t_{n-p_2})} \tag{5}$$

where, the * depends on the results of comparison may take the value of >, =, <.

From the Equations (4) and (5) it is impossible to determine, which sign connects the left and right side. Analysis of these expressions show that if the left side more than the right, it should be preferred option A, otherwise it would be preferable variant B. The main problem in identifying and analyzing routing, various factors is the reconstruction by computer intelligent reasoning, summarizing decisions a person with imprecise and uncertain environment.

To work around this problem is constructed model based on fuzzy systems, showing the relationship between the variables of indicators and exchange. The idea of modeling consists in replacing the mathematical relationship between production car and the parameters that determine it, qualitatively, expressed in terms of linguistic rules. Linguistic fuzzy model generation PBX has six inputs and two outputs. Based on a study of the transportation process, specifically for a given load, set of options exchanges rational.

For considered linguistic variables are constructed corresponding fuzzy sets M with its carrier identified by studying expert estimates. Whereas, by an odd multiple carriers understand the set of X *, such that by constructing the model and create a set of rules has been solved the problem in question routing. We conducted a computer simulation confirmed the viability of the claim is not the feasibility of vehicle routes for heavy-duty large and light-duty on short-haul routes in all cases [6]. The results obtained show that this statement is true only in 23% of cases. At 17%, a comparable equity options and 41% in heavy exchanges should focus on short-haul routes.

V. ANALYSIS MODEL DEPENDING ON THE CAR'S PERFORMANCE CHARACTERISTICS OF THE TRANSPORT PROCESS OF FUZZY

It should be noted that a sufficiently large group of indicators that can be combined on the following elements characterizes the transportation process: supply of rolling stock on the loading point of *i*-supplier, preparing loading cargo on the PBX and execution of relevant documents PBX traffic with load discharge and execution of documents related acceptance of the goods. These elements form the core of the logical system of cargo and its estimation performance vehicle per hour.

Need to develop a mathematical model that takes into account the random nature and uncertainty of individual indicators. Car's performance is an important indicator that provides a reasonable assessment of the implementation of the transportation process to make the right management decisions. Analysis of the relationship reveals productivity reserves efficiency car. It is a necessary tool for the economic mechanism to achieve high performance at lowest cost. One of the main problems in improving the transport process is the study of the fundamental laws of links between the transport processes.

Increased productivity vehicles is one of the major challenges constantly facing road transport workers. To properly address the organization of the transportation process, it is important to know the nature and extent of the influence of individual technical and operational factors on productivity PBX. To analyze the dependence of the performance indicators of the vehicle, which determines the transport process is expedient to use the formula of hourly productivity exchanges, including the full range of transport operations for a complete cycle of the transport process-haul.

$$W_O = \frac{q_H \gamma_c}{\frac{l_{e\tilde{a}}}{\beta_e V_t} + t_{n-p} + t_{oa}} \tag{6}$$

$$W_P = \frac{q_H \gamma_d}{\frac{1}{\beta_e V_t} + \frac{t_{n-p} + t_{oae}}{l_{d\tilde{a}}}} \tag{7}$$

Methods of analysis and definition is the study of functional dependencies production in tonnes and tonne-kilometers on various factors. Part dependence $P = f\,(gn)$, $P = f\,(ig)$ and $P = f\,(\in Hig)$ are linear, and the other part of the $P = f\,(leg)$, $P = f\,(vt)$, $P = f\,(tn - p)$, $P = f\,(bc)$, $P = f\,(tozh)$ fractional linear. In [5-8] etc. to identify the nature of the dependence of the performance of the various factors used technique of chain productions. The essence of this method lies in the fact that the analyzed factors were variable, and other is a constant.

Then, depending on the subject to the first factor productivity $Wp = f\ (k)$ is changed, for Qn, γd, Qn, γd formula, i.e. by law to a straight line through the origin prohodschey reference system for ℓex, βe, vt formula. i.e. by law equilateral hyperbola prohodschey through the coordinate system for the TP - p, with the execution time of these works by the formula. I.e. by law equilateral hyperbola, located in *Neu* - 3 and 33 quadrants and intersecting the axis at a point which is equal to the ordinate a_k / b_k.

From a mathematical point of view, these equations are identical, but differ from each other and the constant coefficients and the values of which are given in Table 1. In fact, when one factor changes, and some factors that were not considered in these papers. Such a change to change the technical capacity of vehicle speed, while loading and unloading. The very technical speed determined interconnected by many factors, which include technical parameters of the PBX - dimensions, base, track, center of gravity height, load capacity, the maximum trailer weight, tare weight, gross weight, the distribution of mass on the axes, turning radius, maximum speed, engine type, maximum power, maximum torque, speed corresponding, respectively.

The maximum power and torque transmission with that of the gear ratios, final drive, transfer gear, the number of wheels, tire size, filling volume, mass units, the technical condition of the engine or the vehicle, suspension settings, work units and the ability *t*. on; geometric characteristics of the road, the driver neurobehavioral performance, the composition of traffic, and traffic intensity. Table 3 shows the driver neurobehavioral performance, the composition of traffic, and traffic intensity.

Table 3. The driver neurobehavioral performance, the composition of traffic, and traffic intensity

under review Factor (k)	The values of the constant coefficient	
	A_k	B_k
$\ell_{\text{ег}}$	$a\ell_{\text{ег}} = q_{\text{н}}\ \gamma_{\text{д}}\ \beta_e v_t$	
β_e	$a\beta_e = q_{\text{н}}\ \gamma_{\text{д}}\ \ell_{\text{ег}} / t_{n\text{-}p}$	$b\ell_{\text{ег}} = \beta_e v_t t_{n\text{-}p}$
v_t	$av_t = q_{\text{н}}\ \gamma_{\text{д}}\ \ell_{\text{ег}} / t_{n\text{-}p}$	$b\beta_e = \ell_{\text{ег}} / v_t t_{n\text{-}p}$
$t_{n\text{-}p}$	$at_{n\text{-}p} = q_{\text{н}}\ \gamma_{\text{д}}\ \ell_{\text{ег}}$	$bv_t = \ell_{\text{ег}} / \beta_e t_{n\text{-}p}$
$q_{\text{н}}$	$aq_{\text{н}} = 1/(\beta_e v_t) + t_{n\text{-}p} / \ell_{\text{ег}}$	$bt_{n\text{-}p} = \ell_{\text{ег}} / \beta_e v_t$
$\gamma_{\text{д}}$	$a\gamma_{\text{д}} = q_{\text{н}} /[1/ (\beta_e v_t)+t_{n\text{-}p}\ell_{\text{ег}}]$	
$q_{\text{н}}\gamma_{\text{д}}$	$aq_{\text{н}}\gamma_{\text{д}}=1/[1/(\beta_e v_t)+t_{n\text{-}p}/\ell_{\text{ег}}$	

The solution to this problem in general is associated with great difficulties. Since it is necessary to take into account a number of factors that have a random variable, in some degree related to the uncertainty caused by failure to obtain the required degree of reliability of the information, any failure to formalize a number of factors the significant role of drivers in performance of the transport process, and so on.

The formalization will serve as a means of increasing uncertainty adequacy calculations of the real conditions of the functioning of the car. The main problem in identifying and analyzing the performance of various factors is the reconstruction by computer intelligent reasoning, summarizing decisions a person with imprecise and uncertain environment. To solve the problem the model is constructed based on fuzzy system, showing relationship between variables x and performance indicators.

The idea of modeling is to replace the mathematical relationship between the performance of the car and the parameters that determine it, qualitatively, expressed in terms of linguistic rules. Odd linguistic productivity model has six inputs and one output. Based on a study of the transportation process is established specifically for a given load rational exchanges among the alternatives.

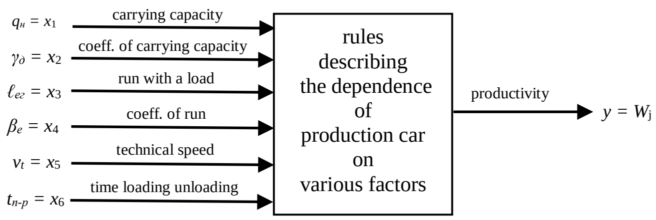

Figure 1. Dependence Proizvoditelonosti PBX from operational factors

Then for the considered linguistic variables are constructed corresponding odd set M with its carrier identified by studying expert estimates. Further, the carrier odd set refers to the set X^*, such that:

$$X^* = \{x / \mu_M(x) > 0, \quad X \in X^* \tag{8}$$

where, $\mu_M(x)$ is Characteristic function belonging.

In the odd logic to define membership function $\mu_M(x)$ can be used direct methods, asked an expert for every $X \in X^*$, and model forms the functions: triangular, trapezoidal, Gaussian, sigmoid, etc. As proviso, direct methods set membership functions are used for measuring concepts such as distance, time, speed, ratio of run, etc. Considered odd system with inputs and one output can be represented as:

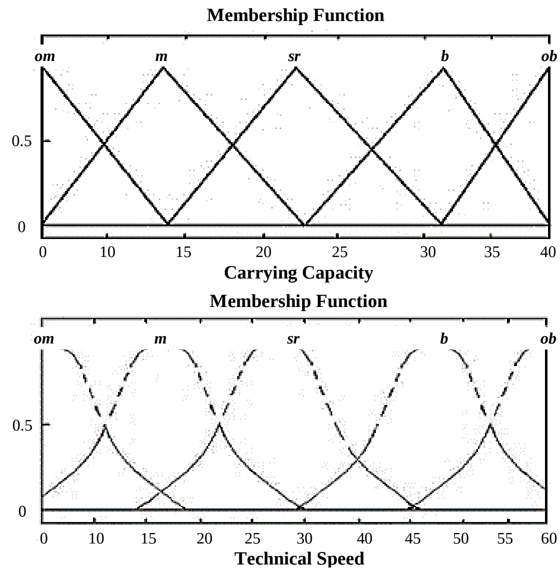

Figure 2. Membership function of selected indicators

If x_1 and x_2 is A_{i1} and A_{i2}, and x_n is A_{in} then $y_i = f_i\ (x_1, x_2, ..., x_n)$, where $i = 1$, m - i - I implication, m is the number of odd rules of the model, $x_1, x_2, ..., x_n$ are the input variables of the model. A_{iy}, $i = 1$, n is fuzzy subsets of input variables, yi is ith input of the system, defined as a nonlinear function of the inputs. MATLAB system operator Mamgani $I_{\max} = (x, y) = \min(x, y)$. The probeg_guzom is *om*) and (koef_isp_path is *sr*) and (tehnich_rate is *ob*) and (*t*(*pr*) is *sr*) then (koef_isp_gruzop is *ob*) and (c-probeg_cargo is *om*) and koef_isp_path is *sr*) and (tehnical speed is *ob*) and (*t*(*pr*) is *b*) then (output is *s*). The results of this given stage of modeling are submitted in the Table 4.

Table 4. The results of this given stage of modeling are submitted

No.	Linguistic variable name	Carriers of a fuzzy set				
1	rated load capacity	particularly small (*om*), 5-7.5	small (*m*), 7.5-10	Average (*sr*), 10-20	large (*b*), 20-30	A very large (*ob*), 30-40
2	coeff. of carrying capacity	particularly small (*om*), 0-0.2	small (*m*), 0.2-0.4	Average (*sr*), 0.4-0.6	large (*b*), 0.6-0.8	A very large (*ob*), 0.8-1.0
3	run with a load	particularly small (*om*), 1-10	small (*m*), 10-30	Average (*sr*), 30-50	large (*b*), 50-80	A very large (*ob*), 80-100
4	coeff. of run	particularly small (*om*), 0.02	small (*m*), 0.2-0.4	Average (*sr*), 0.4-0.6	large (*b*), 0.6-0.8	A very large (*ob*), 0.8-1.0
5	Technical speed	particularly small (*om*), 5-10	small (*m*), 10-20	Average (*sr*), 20-30	large (*b*), 30-40	A very large (*ob*), 40-60
6	The loading and unloading with the waiting time	particularly small (*om*), 0.2-0.4	small (*m*), 0.4-0.8	Average (*sr*), 0.8-1.2	large (*b*), 1.2-2	A very large (*ob*), 2-3

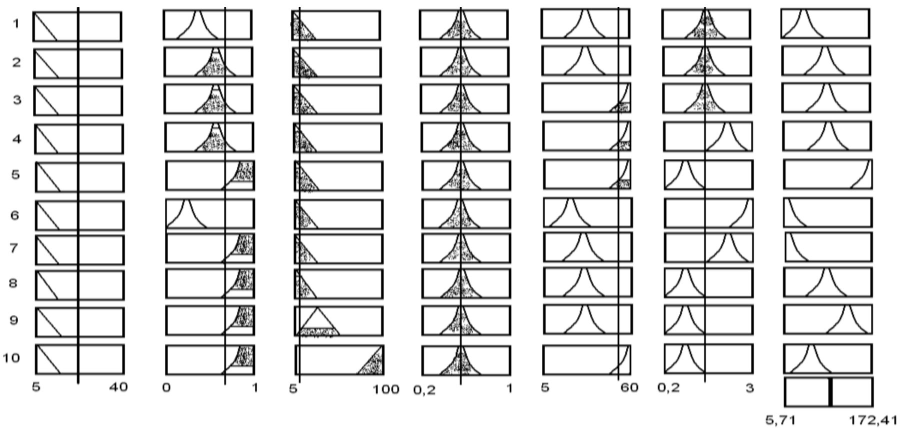

Figure 3. A fragment of the calculations

VI. USE OF FUZZY LOGIC PACKAGE SOLUTIONS FOR THE PROBLEM OF PERFORMANCE ON VARIOUS FACTORS

To solve the problem was to use the package odd logic Fuzzy Logic Toolbox fuzzy subset of values for each variable output (all rules), joined together to form one odd subset for each output variable. In the next, using the ref. [1] is constructed selection rules describing the dependence of performance ATS on various factors. Rules are as follows:

If $A = N$, then $B = M$

If (load is *om*) and (koef_isp_gruzop is *sr*) and (c-probeg_cargo is *om*) and (koef_isp_path is *sr*) and (tehnich_rate is *sr*) and (*t*(*pr*) is *sr*) then (output is *m*) [1]. If (load is *om*) and (koef_isp_gruzop is *b*) and (c-probeg_gzuzom is *om*) and (koef_isp_path is *sr*) and (tehnich_rate is *sr*) and (*t*(*pr*) is *sr*) then (output is *s*) [1]. If (load is *om*) and (c-koef_isp_probeg_cargo is *om*) and (koef_isp_gruzop is *b*) and (c_(output is *sr*) [1]. If (load is *om*) and if (load is *om*) and (koef_isp_gruzop is *ob*) and (probeg_c_gruzom is *om*) and (koef_isp_probega is *sr*) and (tehnich_skorost is *ob*) and (*t*(*pr*) is *m*) then (output is *ob*) [1]. If (load is *om*) and (koef_isp_gruzop is *m*) and (probeg_s_gruzom is *om*) and (*t*(*pr*) is *ob*) then (output is *om*) [1]. If (load is *om*) and (koef_isp_gruzop is *ob*) and (c-probeg_cargo is *om*) and ((koef_isp_path is *sr*) and tehnich_skorost is *sr* and (*t*(*pr*) is *b*) then (output is *om*) [1]. If (load is *om*) and (koef_isp_gruzop is *ob*) and (probeg_s_gruzom is *om*) and (koef_isp_path is *sr*) and (technical speed) and (*t*(*pr*) is *m*) then (output is *s*) [1]. If (load is *om*) and (koef_isp_gruzop is *ob*) and (probeg_c_gruzom is *om*) and (koef_isp_path is *sr*) and (tehnich_skorost is *sr*) and (*t*(*pr*) is *m* then (output is *b*) [1]. If (load is *om*) and (koef_isp_gruzop is *ob*) and (probeg_s_gruzom is *ob*) and (koef_isp_probega is *sr*) and (technical speed) and (*t*(*pr*) is *ob* and (*t*(*pr*) is *m*) then (output is *m*) [1].

The mathematical theory of fuzzy sets can describe fuzzy indicators and knowledge to operate this knowledge and make fuzzy conclusions. Availability of mathematical tools reflect fuzzy initial information allows us to construct a model that is adequate reality. The package Fuzzy Logic Toolbox Mamdani algorithm, which is mathematically described as follows:

1- Fuzzy input: are levels of "cutting off" the preconditions for each of the rules (with operations min):

$$\begin{cases}\alpha_1 = A_1(x_0)B_1(y_0)\\ \alpha_2 = A_2(x_0)B_2(y_0)\end{cases} \tag{9}$$

$$\begin{cases}C_1'(z) = (a_1 \wedge C_1(z))\\ c_2(z) = (a_2 = C_2(z))\end{cases} \tag{10}$$

where, $a \wedge$ denotes the logical operation (min). Then there are the truncated function.

2- Song: with operations max (referred to as *V*) is joined to found the truncated functions, resulting in the final fuzzy subset for a variable output with function:

$$\begin{aligned}&\mu\sum(z) = C_1'(z) v c_2(z) = \\ &= (a_1 \wedge C_1(z) \times v(a_1 \wedge C_1(z) v(a_1 \wedge C_2(z))\end{aligned} \tag{11}$$

3- Finally, the reduction to the definition (for finding z_0) is, for example, the central method in the case of a discrete universe.

$$Z_0 = \frac{\sum_{j=1}^{n} \mu z(W_j) W_j}{\sum_{j=1}^{n} \mu z(W_j)} \tag{12}$$

where, Wj-carrier shutter, in which the membership function reaches its maximum value $\mu z(Wj)$, n is the number of quantization levels of output. By constructing the model and create a set of rules solved the problem. A fragment of the calculations is presented in Figure 2.

VII. CONCLUSIONS

1- Elements of the theory of fuzzy sets have been successfully used in decision-making under uncertainty. There are many studies on decision-making based on fuzzy sets. Meeting the challenges of transport logistics in general is associated with great difficulties, since it is necessary to take into account a number of factors that have a random variable, in some degree due to uncertainty.
2- The formalization of the uncertainty factor in the formation of mathematical models of systems and processes discussed in the article ([1-3], and the other 15 by the author) are a means to improve the adequacy of these models and, as a consequence, the validity and effectiveness of the actual decisions on their basis.
3- Currently, the theory of fuzzy methods are used almost in all areas of application. Choosing an effective PBX on many factors produced using an existing set of preferences, provided a summary of convolution.
4- Solution of routing traffic in general is associated with more difficult because of the need to take into account a number of factors that are random variable, in some degree due to uncertainty. We conducted a computer simulation based on the model confirmed the viability of the claim is not the feasibility of vehicle heavy on long-haul routes in all cases [6]. The results obtained show that this statement is true only in 23% of cases. At 17%, a comparable equity options and 41% in heavy exchanges should focus on short-haul routes.
5- To solve the problem of performance depending on various factors vehicle was used odd logic package Fuzzy Logic Toolbox. Based on the constructed model and create a set of rules solved the problem in question proper to the given load effective exchanges among alternative.

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BIOGRAPHY

Afiq Allahkverdi Allahverdiyev was born in Azerbaijan, in 1937. He received the M.Sc. degree in the field of Road Transport Operation as a Mechanical Engineer from the Polytechnic Institute of Azerbaijan, Baku, Azerbaijan in 1960. He completed his doctoral thesis on "Development of methods and models for optimizing trucking logistics" and graduated in Ph.D. degree in Automation of the Experimental Study from Faculty Retraining Discounts for New, Promising Areas of Science and Technology in Moscow Car and Road Institute, Russian Academy of Sciences, Moscow, Russia in 1985. Currently, he is an Associate Professor in the field of Road Transport and Traffic Safety in Azerbaijan Technical University, Baku, Azerbaijan. He is the author of 163 scientific papers. His research interests lie in the road transport articles large-management, developing methods and models for the optimization of road transport and logistics automation and process control and production.