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METHODOLOGICAL TOOLS FOR THE IMPLEMENTATION OF INFORMATION TECHNOLOGY FOR EXPERT ASSESSMENT OF THE QUALITY OF HEAVY AUTOMOBILE EQUIPMENT IN THE PROCESS OF ITS EXPLOITATION

Subject matter. Justification of the choice of a model range of heavy vehicles when organizing purchases in the framework of large-scale infrastructure projects. **Goal.** Increasing the efficiency of the process of determining the model range of heavy automobile equipment, in terms of its operation, at the stage of initiating large-scale infrastructure projects, by creating a special methodological approach, and on its basis - an appropriate information technology for decision support. **Tasks.** To develop a complex fuzzy model for assessing the quality of heavy automobile equipment during its operation. To propose a method for collective expert assessment of the quality of heavy automobile equipment during its operation. To develop an applied information technology to support decision-making on the formation of a model range of purchased heavy vehicles. **Methods.** System analysis – in the development of a comprehensive model of the quality of heavy automotive equipment; fuzzy mathematics – to ensure the process of fuzzy assessment by experts of the quality of heavy automobile equipment during its operation; expertology – when creating a method for forming a generalized quality assessment by means of collective expert assessment; software engineering – when creating applied information technology for collective expert assessment of the quality of heavy automobile equipment. **Results.** An approach to the creation of a number of applied information technologies for complex expert assessment of the quality of operation of a wide class of vehicles using the example of heavy automobile equipment. **Conclusions.** A comprehensive model has been developed for assessing the quality of heavy automobile equipment, at the stage of its operation, using the principles and approaches that are generally accepted in system analysis. The method of presentation and further implementation of a complex quality assessment model by means of fuzzy mathematics, which makes it possible to increase the efficiency of expert assessment, is described. A method for forming a team of experts is proposed, which implements the selection of an expert from several applicants, while taking into account the communication capabilities of individual members of the team of experts. The applied information technology for complex assessment of the quality of heavy automobile equipment in the aspect of its operation is described, in order to justify the choice of a model range for the acquisition of this equipment in the implementation of large-scale infrastructure projects.

Keywords: heavy automotive equipment; integrated quality model; fuzzy mathematics; collective expert assessment; decision support; applied information technology.

Introduction

In recent years, large-scale infrastructure projects have become widespread in many countries around the world, including Ukraine. A typical example of such a project is the state program "Large Construction", which is currently being implemented and which is initiated by the President of Ukraine. A significant part of the funds that make up the budget of such projects is intended for the purchase of technical means. The specificity of large-scale infrastructure projects (LIP) in many cases is associated with the need to purchase large volumes of various transport mechanisms, including heavy trucks and special equipment based on them. Due to the scale of LIP, heavy automotive equipment (HAE) purchases can reach many hundreds of units, making it an important task to pre-estimate future HAE maintenance costs, including routine maintenance, emergency repairs, and more. Thus, among the many tasks inherent in the life cycle of LIP is quite relevant to justify the choice of the HAE model range, based on the above factors. This task is directly related to quality assessment, in terms of operating costs for the maintenance of HAE. Irrational decisions about the choice of HAE can further lead to unjustifiably large losses of funds, which will reduce the overall effectiveness of LIP.

Many researchers have paid attention to the issue of assessing the quality of heavy engineering products, but the tools they have developed in the course of research have not taken into account the specifics of LIP in terms of assessing the quality of vehicle operation.

These circumstances necessitate the development of special methodological tools, and on this basis - the means of information support for decision-making processes to determine the model range of HAE for the implementation of the planned LIP.

Formulation of a scientific problem and its significance

The problem that determines the relevance of this study is the most fundamental of all the problems of human existence. This is a problem of lack of resources. It, in this case, identifies an applied problem, which is an unacceptably high level of uncertainty about the performance of HAE, and their impact on the quality of LIP in general.

This problem cannot be solved by any top manager alone, because finding a rational option is associated with the need to analyze a large number of factors that are, by their nature, heterogeneous and quite difficult to relate to each other.

Thus, there is a single way to solve this problem, which is to create special models of integrated quality assessment, methods of assessing the values of quality indicators of HAE operation by a team of experts, and making a single, aggregate assessment of a particular HAE model range for implementation of LIP.

These methodological tools should be presented formally with the use of adequate mathematical structures, and then programmatically implemented in the framework of special applied information technology, in the form of a decision support system for those who choose the HAE

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model range.

Analysis of publications on the stated problem

The modern quality management paradigm is based on the concept of Total Quality Management (TQM) and is regulated by a series of relevant ISO 9000 standards [1-5].

In the general sense, quality management is the management of those factors and conditions that most significantly affect the level of product quality. The quality management system covers the entire organization (responsibility, methods, and processes) of enterprise management and is aimed at reliable implementation of quality requirements, which implements all measures of effective and efficient implementation of the company's goals defined in the quality policy [6].

To date, in the theory and practice of quality management there is a fairly well-developed methodological apparatus, which is often associated with ISO standards, various theories of the founders of quality and the concept of TQM [7-10].

The quality of HAE, in particular in terms of operating costs, is the most important factor in its competitiveness, so for any manufacturer of HAE is a very important task in the production of TQM systems [11-13]. However, the level of quality of HAE operation from different manufacturers differs significantly from each other in different indicators [14-16]. This circumstance determines the difficulty of the process of choosing the HAE model line by one person. An effective tool for implementing such tasks is the technology of collective expert assessment [17], and the efficiency of the process can be significantly increased by using the mathematical apparatus of fuzzy mathematics [18], as experts are able to operate during the assessment of their usual linguistic concepts.

The purpose of the article is to solve the problem of increasing the efficiency of the selection process for the purchase of HAE model line during the planning and implementation of LIP, by creating specialized methodological tools for integrated HAE quality assessment through fuzzy collective expert evaluation and development of applied information technology for software implementation and tools in the form of a dialog environment.

Materials and methods of research

We will determine the quality of HAE in terms of operating costs by the formula:

$$Q_c = f\left(Q_p;\, Q_{stg};\, Q_s\right), \tag{1}$$

where: Q_c – assessment of HAE performance by the consumer; Q_p − HAE quality according to TQM; Q_{stg} − quality of related services; Q_s − quality of service.

The indicator Q_p is regularly calculated by world-famous concerns, such as Toyota Motors, Volkswagen, General Motors, Daimler, Ford Motors, Honda Motors, Nissan Motors, Hyundai Motors, BMV, and Peugeot. At the same time, they use differential, complex, mixed and integrated methods common in practice on the basis of expert, sociological, measurement and calculation, experimental and combined approaches. The implementation of these methods involves the use of technical means of control such as, various measuring instruments, installations, tools, scales, auxiliary materials – questionnaires, tables, etc. Specific means of expert activity include professional knowledge of experts, their experience, and intuition.

The problem considered in this study is most consistent with the differential method of assessing the level of product quality, which involves comparing its individual indicators with the corresponding indicators of standard products, taken as a unit, or basic indicators of standards (specifications) and is to calculate values of relative quality indicators – their parametric indices according to formulas:

$$q_i = P_i / P_{io}\left(i = 1 \ldots n\right),$$

$$q_{1,i} = P_{io} / P_i, \tag{2}$$

where q_i − parametric quality index of the i-th parameter being evaluated; P_i − the value of the i-th product quality indicator; P_{io} − the basic value of the i-th indicator of its quality; n − number of indicators.

The implementation of the method assumes that from formulas (2) is selected the one in which the increase in the relative value of the indicator corresponds to the improvement of product quality, for example: other values of service life are calculated by the first formula, and material consumption - by the second.

The advantage of this method is that it allows you to determine a comprehensive indicator of product quality, which is calculated as a consolidated parametric index by the formula:

$$Q_i = \Sigma a_i \times q_i, \tag{3}$$

where a_i − weight of the i-th parameter.

When assessing the level of operational quality of HAE, it is advisable to use well-known in qualimetry comparison methods based on expert assessments based on known scaling, which is just as useful in solving the problem.

Modern information technologies allow the use of appropriate software products to facilitate the modeling of production processes. The activities of automotive companies can be represented as a system of service (SSS) of cars, consisting of interconnected elements: equipment; documentation for maintenance and repair; performers needed to maintain and restore the level of quality and reliability of products, in particular cars.

The car service system is one of the elements of a comprehensive assessment of the quality of automotive products. As an example of improving product quality, consider the model (fig. 1).

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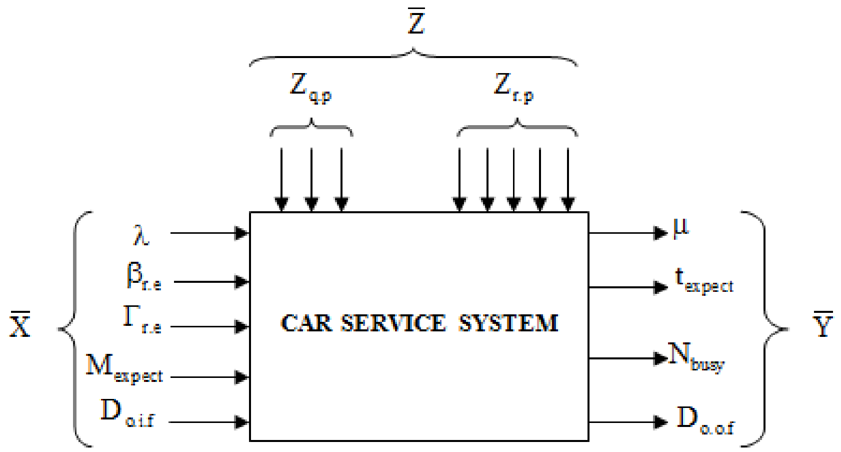


X – vector function of input control factors; λ – the intensity of the flow of requests for repairs; $\beta_{r.e}$ – type of repair effects; $\Gamma_{r.e}$ – grouping of repair influences on complexity and periodicity of carrying out; M_{expect} – the average length of the queue of machines in SSS; $D_{o.i.f}$ – other input factors; Z – vector function of uncontrolled factors; $Z_{q.p}, Z_{r.p}$ – vector function of quality and reliability (initial parameters); μ – parameter of the query service time indicator in the system; t_{expect} – average request waiting time; N_{busy} – the average number of employees engaged in the maintenance of channels; $D_{o.o.f}$ – other initial factors.

Fig. 1. Cyber-model of car service system

Statistical research and observation aims to determine: the density of the incoming request flow (λ), the intensity of the outgoing flow of requests (μ) and service parameters (SP) in SSS with unlimited incoming request flow, diagnostics, technical service (TS) and repair for different brands and car models.

The main way to determine SP requests is the number of service requests over a period of time. The data obtained in these studies are the result of information collected over 3 years. The information reflects the number and type of incoming requests for SP cars, as presented in the information card and accounting documents. The most important are the parameters of testing plans, have accuracy δ and precision β in estimating the average values of the characteristics of the intensity of requests, coefficients of variation. Table 1 shows the sequence of determining the number of objects (n) in the study of their reliability.

Table 1. *The sequence of determining the number of objects (n) in the study of their reliability*

Sequence of computational operations	The law of distribution of the studied random variable	
	normal	**Weibull 0,3< ν <1,0**
Determine the relative error δ on the mean interval t with probability β	δ = 0,05; 0,1; 0,15; 0,2; 0,25; β = 0,05; 0,1; 0,15; 0,2; 0,25;	
Set the predicted coefficient of variation, ν	0< ν <0,3	
Determine the number N of test objects	$N = \left(\frac{\nu}{\delta}\right)^2 \cdot t_\beta; N-1$	$N = \frac{(\delta+1)^\beta}{2} \cdot \chi_{1-\beta}; 2N$

It is advisable to apply the known values of the coefficient of variation in relation to the resource HAE and the laws of distribution [5]. To find them in the normal distribution law, as the studied indicators in mechanical engineering are taken mileage of the machine or its units before the stage of overhaul. The most common value in the normal law of distribution of the coefficient of variation is considered ν = 0,20.

For a fairly complete description of random processes that occur continuously over time in a discrete system, it is necessary to analyze the reasons that cause the transition of the system from one state to another. For a real-time (RF) system, the main factor that determines the processes that take place in it is the flow of orders. This flow consists of its individual components with low intensity, because it is stationary ordinary.

In [6] it was shown that when collecting individual flows into an integral one, we obtain a flow quite close to the flow, which is characterized by a "Poisson" distribution of the probability of events, provided that the number of these flows goes to infinity. For practical needs, it is enough to use 4-5 threads to get a single distribution stream. Since the intensity of the flow of requests is a function of the intensity of the mileage HAE, for those car owners whose loads on the machines are uniform, enter λ = const. In this case, the demonstration of the flow and research on it are significantly simplified [9].

The mathematical expectation of the number of orders X on SP during the day can be determined by the formula.

$$M[x]=\sum_{i=1}^{k} xi \frac{ni}{n}, \quad (4)$$

where n – squares of deviations.

The hypothesis is tested using the Pearson test (χ^2).Checking the consistency between the theoretical and experimental distribution is that the size of the difference between them is determined as the sum of the squares of the deviations $\left(\frac{n_i}{n}-P_{xi}\right)^2$, that is:

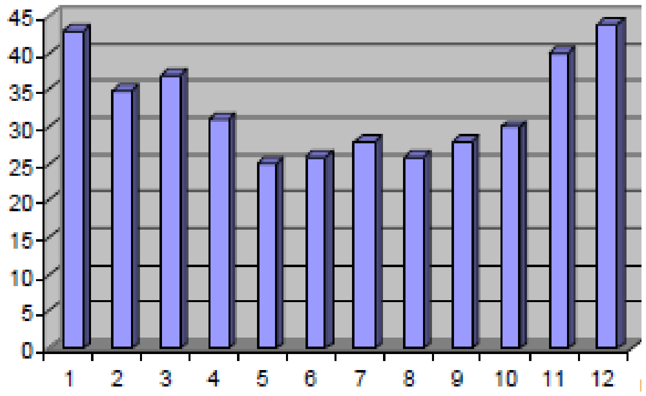
$$\chi^2=U=\sum_{i=1}^{k}\frac{(n_i-nP_{xi})^2}{nP_{xi}}. \quad (5)$$

where nP_{xi} – theoretical absolute frequency after joining; n_i – absolute frequency after joining based on experience; k – number of classes after joining.

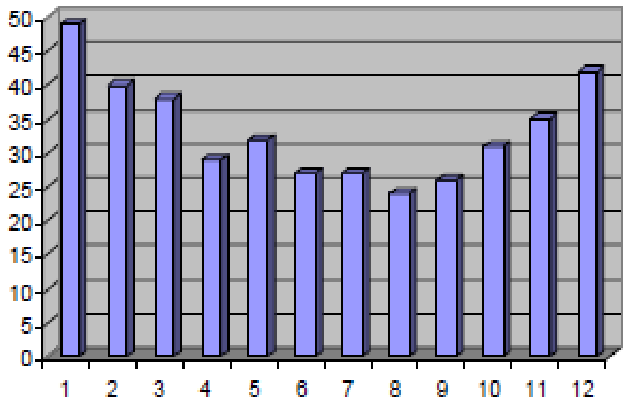
Analysis of information on the number of requests per month for the period of research in specialized branded centers, allows us to determine that the parameter flow λ of RP requests, which is a function of the failure rate of cars is directly dependent on their workload. Where the load of the machine is uniform, we can assume that the flow of failure rate is a constant value, and, consequently, the flow of requests for RS is constant.

The analysis of information on appeals to service centers showed that the time period for cars of four brands (studied) can be divided into two periods: in the studied periods of time the parameters of the flow of requests λ are different, and therefore the organization of requests should be different.

According to the results of the study, using formulas 4, 5, empirical and theoretical distribution curves were constructed, the average number of requests in the RP of the studied brands of Skoda, Citroen for 2020, which is presented in fig. 2.



a)



b)

Fig. 2. The average values of the parameters of the flow of requests λ for RP depending on the study period (months 2020) of the following brands of cars: a) Skoda; b) Citroen

The study of the average values of the parameters of the flow λ of requests in the RP performed on four SSS operating in Ukraine, allowed to obtain the main numerical characteristics of the law of distribution of request flows for repair and maintenance effects on some basic elements of cars.

The study determined both the time costs for different types of services and the values of the average intensities of the output streams of RP requests in the tested service centers. Considered: engine, clutch, transmission, rear and front axles, chassis (brake system).

Based on the results of the research, the approach to making the right informed decisions was determined and a conceptual model of management information support was developed. This model includes a set of blocks that are connected in series.

Rational decision-making is carried out in the blocks of the first group, and provides a detailed analysis and expert evaluation of the formed decisions.

Since the technology of strategic management involves, in some cases, the restructuring of the SSS, the second group of units implements a regulated sequence of actions for the restructuring of the SSS, in particular, the relevant tangible and intangible assets.

The third group of blocks is designed to evaluate and justify decisions to determine the HAE model line for procurement under LIP.

The model described above, in principle, is suitable for solving a wide range of practical problems related to the justification of the choice of model range not only cars but also other technical means, such as various technical equipment (machines, units, etc.). At the same time, the specifics of LIP create risks of very large financial and time losses due to making irrational decisions. This fact necessitates the addition of a comprehensive model for assessing the operational quality of HAE with a set of special functional units designed to improve the efficiency of the quality assessment process. Thus, in the first group of blocks it is advisable to apply the representation of a set of factors that determine the operational quality of HAE in the form of linguistic variables with appropriate scales. This expansion of the integrated model will increase the comfort of experts, which will directly affect the efficiency of the whole process.

Let's present a comprehensive model for assessing the operational quality of HAE in the form of a "black box", the input of which provides information about the factors that determine the quality of operation P. Multiple factors from the set P are characterized by the degree of importance V and intensity of the flow of applications for TS I (in time). The main parameters for each factor are the threshold values – lower K_l and upper K_{up}. At the output of the model, a set of relevant estimates of the level of operational quality of HAE C is formed.

Consider the parameters of the complex HAE model described above as linguistic variables.

It is known that a variable is called linguistic if its meanings are words, phrases of natural language. The linguistic variable can be described by a set (X, T, U, G, M), where X – variable name; T – term set of a variable X, that is, the set of all names of linguistic values of a variable X, and each of these values is a fuzzy variable X with values from the universal set and with the base variable U; G – syntactic rule that generates names X of the value of the variable X; M – a semantic rule that matches each fuzzy variable X to its meaning M (X). The concrete name X, generated by a syntactic rule G, is called a term.

In turn, a fuzzy subset M is defined as some set X with the function of belonging $\mu_M(X)$, which takes values from the interval [0, 1]:

$$M = \int_{x\in X} \mu_M(X)/X ,$$

where $\mu_M : X \to [0, 1]$ – function of belonging.

Let's assume that the most important factors for assessing the performance of HAE are the values of variables K_l, K_{up} and P. Let the area change K_l determined by the interval [9…30], K_{up} – [20...40], P – [1...7]. An absolute scale was used to determine the intervals.

On the basis of the data which can be received as a result of interrogation of experts, for the considered linguistic variables such term sets are defined.:

T (lower quality threshold K_l) = lower than acceptable + acceptable + higher than acceptable;

T (upper quality threshold K_{up}) = lower than acceptable + acceptable + higher than acceptable;

T (the intensity of the flow of applications for TS I) = below normal + normal + above normal.

We also define the linguistic variables that describe the initial parameter of the model, namely the set of relevant estimates of the level of operational quality of HAE C, with areas of change in this value are respectively in the range [9…30].

Based on the above, term sets can be written as:

T (the lower limit of the level of operational quality of HAE C_l) = small + average + high;

T (the upper limit of the level of operational quality of HAE C_{up}) = small + average + high.

For each term, a corresponding fuzzy set is constructed from the term sets defined for linguistic variable M with its carrier, which is determined on the basis of the study of expert assessments. In this case, the carrier of the fuzzy set means the set X', such as:

$$X' = \{x \mid \mu_M(X) > 0, x \in X'\} .$$

The results of fuzzification of a comprehensive model for assessing the operational quality of HAE are presented in table 2.

Table 2. *Fuzzy values of parameters of the complex model of evaluation of operational quality of HAE*

The name of the linguistic variable	Terms	Fuzzy set medium
Lower quality threshold K_l	Low	9-22
	Average	19-25
	High	24-30
Upper quality threshold K_{up}	Low	20-25
	Average	24-33
	High	31-40
The intensity of the flow of applications for TS I	Below the norm	1-5
	Norm	3-6
	Above the norm	6-7
HAE performance level C	Small	9-15
	Average	14-24
	High	23-30

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The next stage of phasing of the complex model [19] of HAE performance assessment involves the construction of a set of rules describing the level of HAE performance. The rules are generalized

$$\text{IF } A = N\text{, THEN } B = M\,,$$

where A, B – linguistic variables; N, M – terms of the corresponding linguistic variables.

For example:

IF the lower quality threshold = <high>,

THEN quality level = <medium>.

A matrix of fuzzy relations is built on the basis of a set of rules. As is known, a fuzzy binary relation R is a subset of a Cartesian product $X \times Y$:

$$R = \int_{(x,y)\in X\times Y} \mu_R(x,y)/(x,y)\,.$$

Next, the constructed matrices are combined

$$\mu_R = \max(\mu_{R_1},...,\mu_{R_n})\,.$$

For the organization of the logical conclusion the compositional rule of the logical conclusion which separate case is the known syllogism Modus Ponens is used.:

$$\text{BASIS 1 IF } x \in A\text{, THEN } y \in B$$

$$\text{BASIS 2} \qquad x \in A$$

$$\text{BASIS} \qquad y \in B\,.$$

There are quite a number of fuzzy relations used in the compositional rules of inference. But in this case it is appropriate to apply one of three rules:

1. $R_m = (A\times B)\cup(\neg A\times V) = \int_{u\times v} (\mu_A(u)\wedge\mu_B(v))\vee(1-\mu_A(u))/(u,v).$

2. $R_a(\neg A\times V)\oplus(U\times B) = \int_{u\times v} (1\wedge(1-\mu_A(u))+\mu_B(v))/(u,v).$

3. $R_C = A\times B = \int_{u\times v} \mu_A(u)\wedge\mu_B(v)/(u,v).$

The specifics of LIP life cycle management, including the solution of the problem of determining the HAE model range, necessitates the use of a number of special methods based on the principles of the competency approach in the selection of applicants for inclusion in the team of experts. Collective expert evaluation is largely determined by the fuzzy nature of the process of forming evaluations by both individual experts and the team of experts as a whole. These circumstances indicate the feasibility of using fuzzy logic in collective expert evaluation, in order to reduce the impact of uncertainty on the objectivity of expert evaluation.

The expert survey procedure can lead to several cases, each of which requires special methods of processing the survey data. However, quite often in practice it all comes down to averaging in one way or another assessment of individual experts. Obtaining an average assessment will be justified only if there is a sufficiently high consistency of expert assessments. If several groups are formed in the expert commission, standing in significantly different positions, then a simple averaging of the assessments of all experts will be meaningless.

Subgroups of experts (usually small) or individual experts, whose assessments differ quite sharply from the assessments of the majority, have been called "dissidents" in the literature. In order to artificially achieve consistency in the assessments of dissident experts are excluded from the expert group. However, they may include original thinkers who have delved deeper into the problem than most experts.

A mild way to combat dissidents is to use robust (stable) statistical procedures, namely the use of methods that are known in the theory of rough sets.

When performing an expert operation (in the case when the assessments of experts are expressed in the scale of relations) with the appointment of weights of criteria and alternatives, the number of which can be quite large (more than 10), there are some difficulties. This is due to the fact that in such conditions, the expert is quite difficult to rank or break the elements. To solve this problem, the method of pairwise comparison of elements (objects) is widely used, which in turn is the basis for other methods of analysis of multicriteria alternatives (ordinal sum method, generalized ordinal sum method for incomplete pairwise comparisons, hierarchy analysis method, and scalar convolution method), etc.).

The application of the above formal means of collective peer review aims to increase the objectivity of the decisions made regarding the justification for the choice of the HAE model line at the stage of LIP initiation.

In the course of the research an applied information technology was developed, the description of which in the IDEF0 notation is given in fig. 3.

The application of the developed information technology, based on CASE-tools, common in the practice of software engineering, will increase the efficiency of the process of assessing the operational quality of HAE by reducing the risks of irrational decisions that lead to financial losses in both HAE procurement and operation.

Conclusions and prospects for further research

1. A comprehensive model for assessing the quality of heavy vehicles, at the stage of its operation, using the principles and approaches that are generally accepted in the system analysis.

2. The method of presentation and further realization of the complex model of quality estimation by means of

fuzzy mathematics that increases efficiency of expert estimation is stated.

3. A method of forming a team of experts is proposed, which allows to justify the choice of an expert from a number of applicants and to draw conclusions about the communication capabilities of individual members of the team of experts.

4. The applied information technology of complex assessment of quality of heavy automobile equipment in the aspect of its operation is described, for the purpose of a substantiation of a choice of a model line for purchase of this equipment at realization of large-scale infrastructure projects.

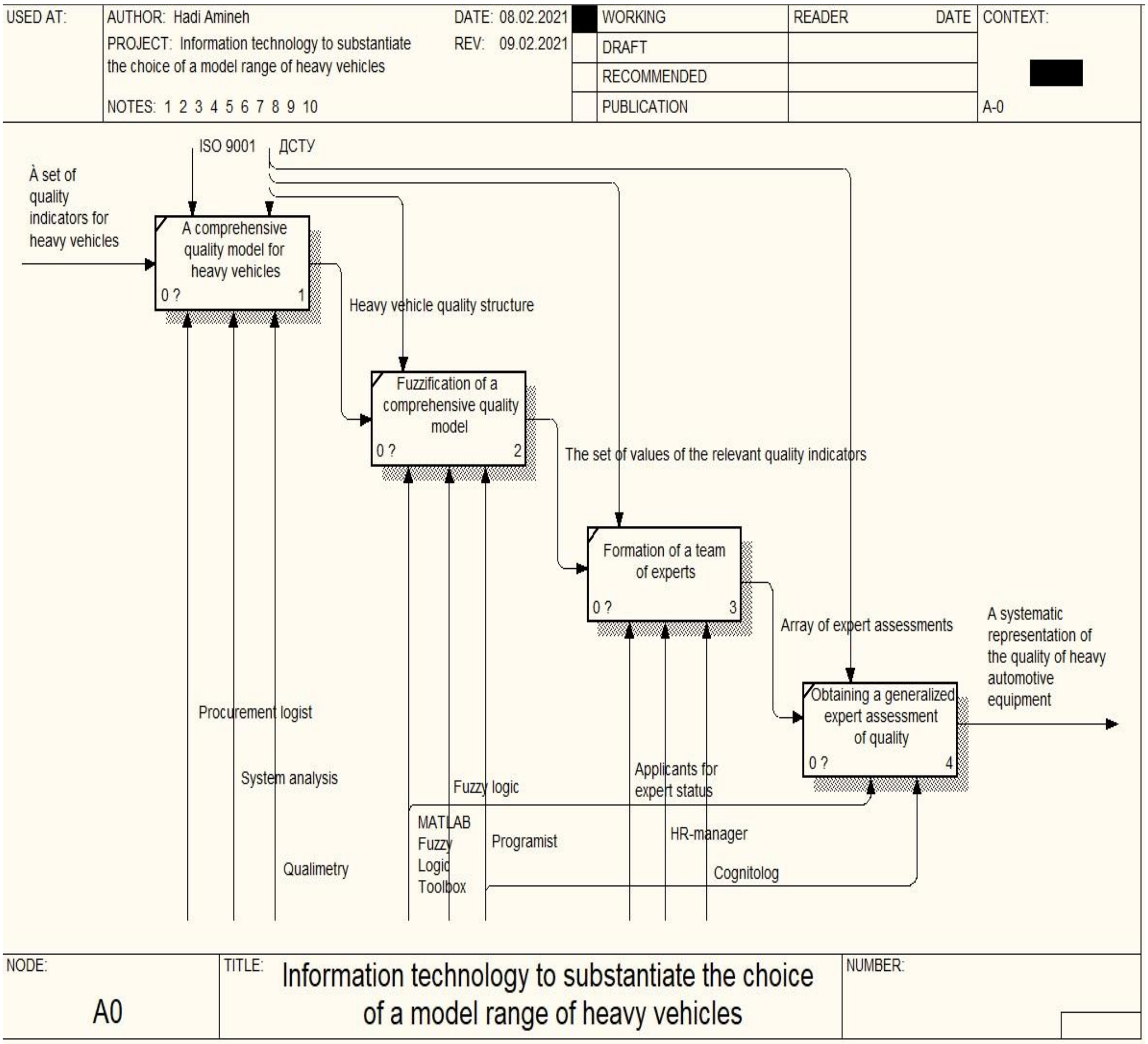

Fig. 3. Applied information technology for substantiation of the HAE model line in the process of planning and implementation of LIP

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МЕТОДИЧНІ ЗАСОБИ РЕАЛІЗАЦІЇ ІНФОРМАЦІЙНОЇ ТЕХНОЛОГІЇ ЕКСПЕРТНОГО ОЦІНЮВАННЯ ЯКОСТІ ВАЖКОЇ АВТОМОБІЛЬНОЇ ТЕХНІКИ В ПРОЦЕСІ ЇЇ ЕКСПЛУАТАЦІЇ

Предмет. Обґрунтування вибору модельного ряду важкої автомобільної техніки при організації закупівель в рамках великомасштабних інфраструктурних проєктів. **Мета.** Підвищення ефективності процесу визначення модельного ряду важкої автомобільної техніки, в аспекті її експлуатації, на етапі ініціації великомасштабних інфраструктурних проєктів, шляхом створення спеціального методичного підходу, а на його основі – відповідної інформаційної технології підтримки прийняття рішень. **Завдання.** Розробити комплексну нечітку модель оцінювання якості важкої автомобільної техніки в ході її експлуатації. Запропонувати метод колективного експертного оцінювання якості важкої автомобільної техніки в ході її експлуатації. Розробити прикладну інформаційну технологію підтримки прийняття рішень щодо формування модельного ряду важкої автомобільної техніки, що закуповується. **Методи.** Системний аналіз - при розробці комплексної моделі якості важкої автомобільної техніки; нечітка математика – для забезпечення процесу нечіткого оцінювання експертами якості важкої автомобільної техніки в ході її експлуатації;

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експертологія – при створенні методу формування узагальненої оцінки якості шляхом колективного експертного оцінювання; програмна інженерія – при створенні прикладної інформаційної технології колективного експертного оцінювання якості важкої автомобільної техніки. **Результати.** Підхід до створення низки прикладних інформаційних технологій комплексного експертного оцінювання якості експлуатації широкого класу транспортних засобів на прикладі важкої автомобільної техніки. **Висновки.** Розроблено комплексну модель оцінювання якості важкої автомобільної техніки, на етапі її експлуатації, з використанням принципів та підходів, що є загальноприйнятими у системному аналізі. Викладено метод представлення й подальшої реалізації комплексної моделі оцінювання якості засобами нечіткої математики, що підвищує ефективність експертного оцінювання. Запропоновано метод формування колективу експертів, що надає змогу обґрунтувати вибір експерта з низки претендентів та зробити висновки про комунікаційні можливості окремих членів колективу експертів. Описано прикладну інформаційну технологію комплексного оцінювання якості важкої автомобільної техніки в аспекті її експлуатації, з метою обґрунтування вибору модельного ряду для закупівлі цієї техніки при реалізації великомасштабних інфраструктурних проєктів.

Ключові слова: важка автомобільна техніка; комплексна модель якості; нечітка математика; колективне експертне оцінювання; підтримка прийняття рішень; прикладна інформаційна технологія.

МЕТОДИЧЕСКИЕ СРЕДСТВА РЕАЛИЗАЦИИ ИНФОРМАЦИОННОЙ ТЕХНОЛОГИИ ЭКСПЕРТНОГО ОЦЕНИВАНИЯ КАЧЕСТВА ТЯЖЕЛОЙ АВТОМОБИЛЬНОЙ ТЕХНИКИ В ПРОЦЕССЕ ЕЕ ЭКСПЛУАТАЦИИ

Предмет. Обоснование выбора модельного ряда тяжелой автомобильной техники при организации закупок в рамках крупномасштабных инфраструктурных проектов. **Цель.** Повышение эффективности процесса определения модельного ряда тяжелой автомобильной техники, в аспекте ее эксплуатации, на этапе инициации крупномасштабных инфраструктурных проектов, путем создания специального методического подхода, а на его основе – соответствующей информационной технологии поддержки принятия решений. **Задание.** Разработать комплексную нечеткую модель оценки качества тяжелой автомобильной техники в ходе ее эксплуатации. Предложить метод коллективного экспертного оценивания качества тяжелой автомобильной техники в ходе ее эксплуатации. Разработать прикладную информационную технологию поддержки принятия решений по формированию модельного ряда закупаемой тяжелой автомобильной техники. **Методы.** Системный анализ - при разработке комплексной модели качества тяжелой автомобильной техники; нечеткая математика – для обеспечения процесса нечеткого оценивания экспертами качества тяжелой автомобильной техники в ходе ее эксплуатации; экспертология – при создании метода формирования обобщенной оценки качества путем коллективного экспертного оценивания; программная инженерия - при создании прикладной информационной технологии коллективного экспертного оценивания качества тяжелой автомобильной техники. **Результаты.** Подход к созданию ряда прикладных информационных технологий комплексного экспертного оценивания качества эксплуатации широкого класса транспортных средств на примере тяжелой автомобильной техники. **Выводы.** Разработана комплексная модель оценки качества тяжелой автомобильной техники, на этапе ее эксплуатации, с использованием принципов и подходов, которые являются общепринятыми в системном анализе. Изложен метод представления и дальнейшей реализации комплексной модели оценки качества, средствами нечеткой математики, который дает возможность повысить эффективность экспертного оценивания. Предложен метод формирования коллектива экспертов, который реализует выбор эксперта из нескольких претендентов, при этом учитываются коммуникационные возможности отдельных членов коллектива экспертов. Описана прикладная информационная технология комплексной оценки качества тяжелой автомобильной техники в аспекте ее эксплуатации, с целью обоснования выбора модельного ряда для приобретения этой техники при реализации крупномасштабных инфраструктурных проектов.

Ключевые слова: тяжелая автомобильная техника; комплексная модель качества; нечеткая математика; коллективное экспертное оценивание; поддержка принятия решений; прикладная информационная технология.

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