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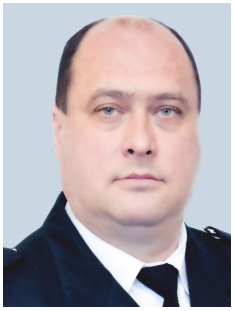

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APPROACHES TO THE DEVELOPMENT OF THE COMPLEX METHOD OF EXPERTISE AT ENTERPRISES

Abstract. Attention is paid to the fact that in order to make reasonable decisions, it is necessary to rely on the experience, knowledge and specialists' intuition. A large number of methods for obtaining expert assessments, has been noted.

The methods of examination are also differ, in some of them work is being done separately with the expert, in others the problem is being discussed collectively, opinion of other experts is being studied, incorrect ways of decision are being rejected. It is also emphasized that there is diversity at all stages of the examination: formation of the group by number, qualifications of experts. Using of statistical data processing also differs significantly, from mathematical to computerized. The main methods and stages of expert evaluation have been given. Emphasis is being placed on assessments, their classification according to various criteria and characteristics. Conditions for measuring of qualitative and quantitative characteristics and the main requirements for them are being indicated. Attention is being paid to the conditions of using of the interval scale and the order scale. The methodology of experts' work in case of definition of probabilistic expert estimations is being described. Peculiarities of using the methods which are most often used in practice have being described, among which are method of academician V. Glushkova, morphological method, QUEST, PATTERN, SEER methods and Delphi method. A combined method of examination at enterprises with specific working conditions is being proposed. The algorithm of examination has been developed and the main stages of examination, and functions of the persons which are taking part in examination have been olefined. The main requirements to the automated expert system have been highlighted.

Keywords: *examination, method, evaluation, classification, stages, experts*

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Introduction. The current state of many enterprises in Ukraine can may be described as transitional, ie the state of search for new forms, methods and approaches to the organization of production and management processes. It is necessary to use techniques that have not been widely used before, namely methods based on the assumption that on the basis of the opinions of experts it is possible to build an adequate picture of enterprise development with specific production conditions, which will consider qualitative and structural changes.

The essence of the methods of examination is to take into account the views of experts, based on the generalization of their own and world experience of research and development in the projected industry or production. The application of all methods of expert assessments is based on the hypothesis that the expert has the so-called "practical wisdom", insight related to a particular field of knowledge or practice.

Analysis of the recent research and publications. At present, considerable attention is paid to both the methodological issues of the examination and the forms of the examination. Experts estimate that there are now at least 100000 articles and books that offer a variety of approaches to dealing with expertise or processing information on peer reviews. At the same time, all the variety of conditions and situations in which experts have to work and take responsibility for the adequate assessment of various factors and indicators is noted.

G. Bammer, M. O'Rourke and G. Richardson (2020) note that during the examination most of the knowledge is hidden. The application of expertise should be comprehensive. This should include three areas: (a) specific approaches, including interdisciplinarity, transdisciplinarity, systems thinking and the science of sustainability; (b) individual experience that is independent of those specific approaches; and (c) research examining elements of integration and implementation. The authors propose to create a knowledge bank that will accumulate success in solving complex problems, including social and environmental.

J. MacMillan and D. Entin (1993) note the specifics of conducting expertise in complex areas, where there may be no agreed levels of knowledge and there is no single correct answer to the problems, and monitoring and measuring the actual work of experts is difficult. During the experiment, the qualification of specialists in decision-making was assessed depending on the level of their theoretical training.

C. Hmelo-Silver and M. Pfeffer (2004) emphasize that only trained experts can assess complex systems. They should be able to build a network of concepts and principles in the area being assessed that represents the key phenomena and their interrelationships. Newcomers who were invited as experts evaluated the static components, while more experienced experts gave an assessment considering dynamic phenomena.

St. Beck (2015) pays attention to the fact that a balanced theoretical and methodological approach is required when conducting an examination. The author proposes a new methodological approach to carrying out an examination, considering the relational conceptualization of experience, while they compare anthropological and pragmatic theories.

M. Thomas and L. Buckmaster (2013) point out that all complex and problematic issues, especially those related to public risks, should be reviewed. This applies to areas such as science, engineering, law and economics and others, as well as for legislators in providing them with a fundamental basis for making legitimate decisions when discussing complex issues of public policy.

R. Grundmann (2017) offers a theoretical framework for analyzing experiences and experts in modern societies. The author focuses on the fact that the issues of conducting an examination in the historical and social context, as well as using the relational aspect of expert knowledge, are not sufficiently considered.

Thus, it can be noted that the specifics of the examination largely depends on the object and characteristics of the research. Many aspects of the system and the

external environment must be taken into account.

Purpose of the article. Considering the peculiarities of production at enterprises with specific production conditions, as well as the specifics of monitoring the efficiency of equipment and facilities, management of production processes and timely decision-making, it is necessary to develop an effective methodology for examination of all.

Formulation of the main material. The solution of complex problems of systems analysis is usually carried out using a multivariate research approach. However, when carrying out the procedure for expert assessment of various objects and factors, within the same system, researchers are faced with a variety of nature and a variety of properties of the objects under study. From this point of view, expert analysis can be carried out using various methods of implementation, methods of processing estimates, etc. Therefore, the expert analysis is divided into separate procedures for expert assessment of individual factors, which is called expert examination.

Expert analysis includes such processes as model formation, obtaining and processing expert assessments and interpretation of results. The main stages of the expert analysis and the functions of the persons involved can be represented as follows (Fig. 1):

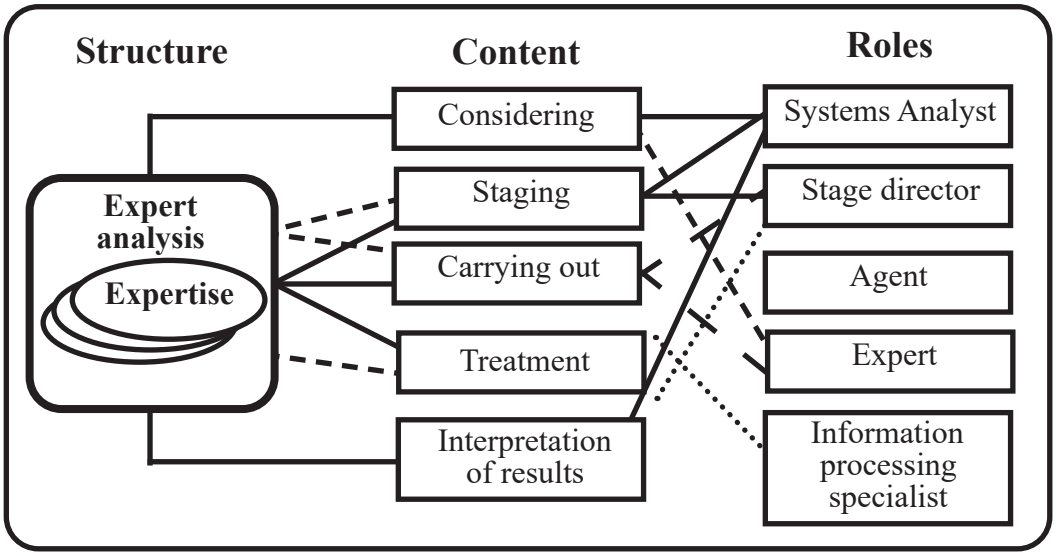

Figure 1 – The structure and content of the expert analysis

– Building a model. The purpose of this stage is to structure the subject area and the task of analysis. The main actor here is the analyst, who interacts with experts to identify factors and their interrelationships.

– Statement of expert analysis. The task of this stage is a formalized description of the procedure for obtaining expert assessments. The task designer, together with the analyst, chooses the methods of assessment, criteria, scales, and the scenarios of the survey and questionnaires are developed.

– Conducting an expert survey and obtaining estimates. This stage involves direct interaction of the director with experts. At this stage, such difficulties arise as the high workload of the director, the geographical remoteness of the experts, and communication failures. To solve these problems, an intermediary is involved, i.e. agent.

– Processing of expert assessments. The task of this stage is to obtain a generalized opinion based on multiple judgments of experts. At this stage, a specialist in the processing of statistical material can be involved, who is able to select and implement the correct processing technique.

– Interpretation of results. The purpose of this stage is to answer the question for what aim this work was carried out. The systems analyst interprets the results

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according to the meaning that was put into the model at the initial stage.

It should be noted that often the role of an analyst, director and information processing specialist is combined by one person. This structure of expert analysis allows us to specify the basic requirements for an automated system, which are as follows:

– to allocate subsystems and determine their tasks and functional purposes;

– to determine the composition and attributes of the main information objects of expert analysis;

– highlight the main analytical tasks;

– to classify the users of the system;

– for each of the users of the system, determine the content requirements for the interface;

– on this basis to design the structure of the system.

It should be noted that all methods of expert evaluation are divided into two types – methods of individual and methods of collective expert evaluation (Fig. 2) (Arrow, 2004, 204 p).

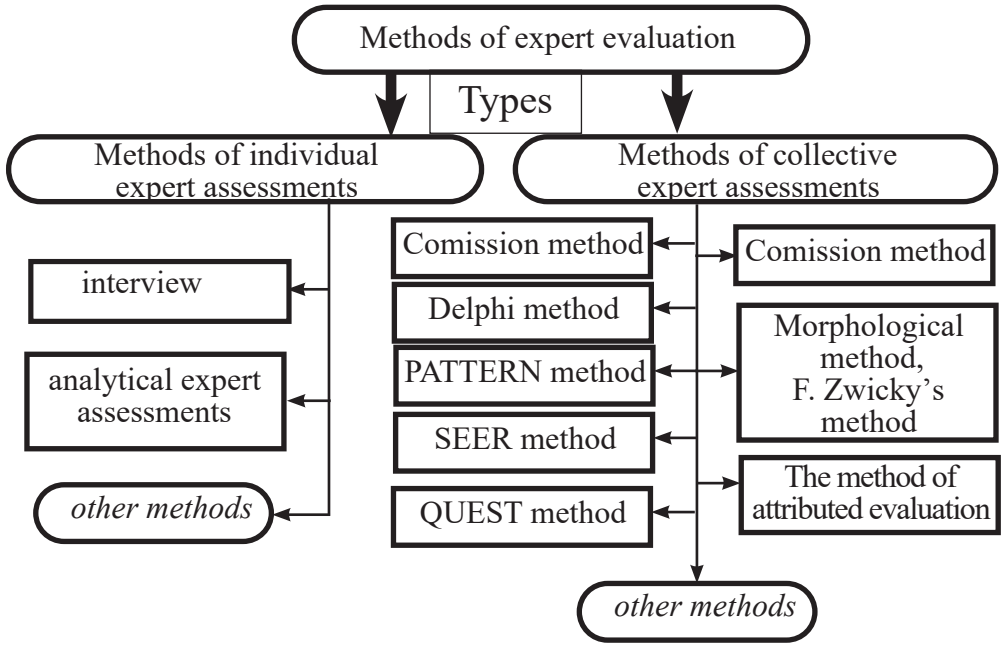

Figure 2 – Types and methods of expert assessments

In this case, the division into methods of individual and collective expert assessments is carried out on a quantitative basis, on the basis of which a forecast is developed based on the opinions of one expert or group of experts.

B. Mirkin (1974) pay attention to the fact that in economic research, decision theory, an important role is played by advantages, which include such concepts as choice, usefulness, probability. There are four main components to all types of assessments: subject, subject, nature, and basis.

The subjects of the assessment are individuals and legal entities that regulate and control it, can order such an assessment or implement it.

The subject of evaluation is those objects to which values are attributed or objects whose values are compared.

By their nature, estimates are divided into absolute and comparative. In absolute assessments, terms such as "good", "bad", "good", "evil" are used. Comparative assessments are made using the terms "better", "worse" and "equivalent".

The basis of the assessment is understood as the position or those arguments

that incline it to a certain advantage. In expert evaluation, different assessments can be obtained for example but different grounds.

It is proposed to divide the features of objects into two types. The first includes quantitative characteristics measured using known standards. For example, in monetary units it is possible to estimate innovations, the profit, a salary, the income per capita; distribution of working time to perform production functions – in hours; age of staff – in years and so on. The second type of feature used in the object research is qualitative. Qualitative characteristics of objects do not have established measurement standards. They are set according to the structure of the object itself and according to the research hypothesis.

To evaluate qualitative characteristics, it is necessary to determine the measure of the intensity of the expression of the property of the object, ie to obtain a quantitative expression of qualitative evaluation. For this purpose of measurement of qualitative characteristics of objects the special standard of measurement (scale) which has to satisfy the following basic requirements is constructed:

– it must measure the properties and characteristics that are planned for measurement, without mixing them with others (the principle of validity of measurement);

– repeated measurements of the object should give the same results as the previous ones (scale stability requirements);

– the degree of reflection of the property or feature should be clearly visible (scale accuracy requirement).

In the expert evaluation of objects, two types of scales are most often used (B. Flyuverh, 2006): the scale of intervals and the scale of orders. Using them as benchmarks makes it possible to score and rank objects.

The interval scale is used to display the magnitude of the difference between the properties of objects and is a fully ordered numerical series with measured intervals between points. The same number is assigned to the equivalent of the compared characteristics of the objects. The main property of the interval scale is the equality of intervals, and it can have arbitrary reference points and scale.

The scale of order is used to arrange objects individually or in a set of features on the principle of "better", "worse", "less than", "more than" and the like. In this case, it is said that the ordered elements are ranked. The values in the order scale show only the order of the objects and do not allow you to determine the numerical value of the advantage of one object over another.

To use probabilistic expert assessments in research, the interpretation of probability theory in terms of weights is also used, when the weight of probabilistic expert assessment is understood as the degree of expert confidence in a given event result. Determining probabilistic expert estimates in terms of weights implies an implicit scaling of expert preferences. The following rules for assigning (setting) weights to any of the probabilistic events are used:

– the weight assigned to any event must be a number between zero and one inclusive;

– the sum of the weights assigned to any number of mutually exclusive events must be equal to one;

– if two or more mutually exclusive events are grouped into one event, the weight assigned to that event must be equal to the sum of the weights assigned to the initial events.

B. Mirkin (1974) offers the following classification of types of expert assessments (Fig. 3). It should be noted that quantitative indicators are used when it is possible to compare values – how many, or how many times, one estimate is greater than another.

Scores on a scale and rank scale usually characterize the subjective opinions of experts. The value of the scale is a limited discrete series of numbers spaced at the same distance.

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Ranking refers to the representation of objects in the form of a sequence in order to reduce their preference. Ranking can be represented as a score on a scale: the rank of the object a (i.e. the value of f(a)) can be considered the number of places it occupies in the ranking in the reverse numbering of places.

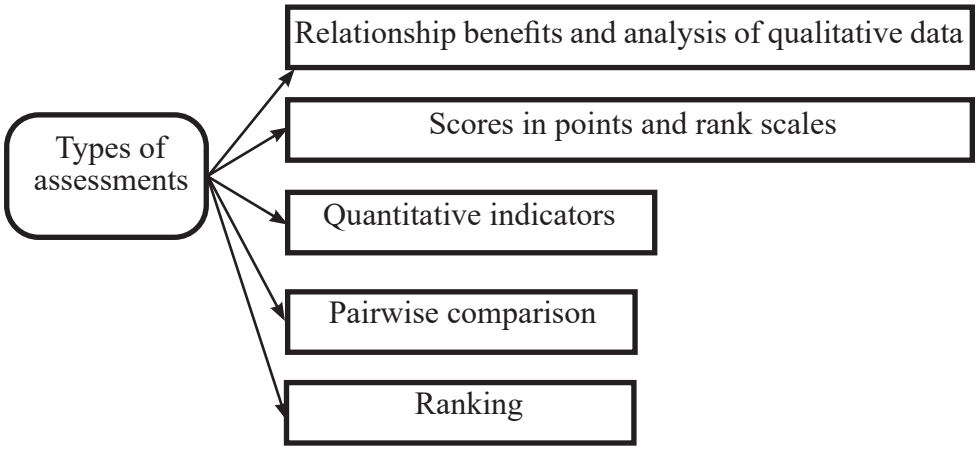

Figure 3 – Classification of types of expert assessments

A pairwise comparison indicates the object that is preferred for each selected pair of objects. It is sometimes permissible to characterize them as both equal or incomparable.

However, as the scientists note (N. Bazaliys'ka, & B. Flyuverh, 2006), that that the number of objects increases, the number of required comparisons increases almost in proportion to the square of the number of objects. Therefore, for 11 – 15 objects (which requires from 55 to 105 comparisons) the application of the method is almost impractical.

Benefit relationships and quality data analysis are used to reconcile individual assessments and objective indicators of objects measured on different scales by moving to the same data type, numerical or qualitative.

Of the methods most often used in practice, the following should be noted: the method of Academician V. Glushkova, morphological method, QUEST, PATTERN, SEER methods and Delphi method.

The essence of the method proposed by Academician V. Glushkov is to build and further analyze the model of a complex network of relationships that arise in solving promising scientific and technological problems. This provides the opportunity to form many different options for scientific and technological development, each of which leads in the long run to achieve the goals of the projected industry. Further analysis of the model allows to determine the optimal (according to a number of criteria) ways to achieve the goal.

The morphological method was proposed by the Swiss astronomer F. Zwicky. This method is based on a pre-designed scheme of consideration of predicted objects, designed to identify possible solutions to a multifaceted problem. There are different types of characteristics of the analyzed objects, their different properties with the characteristics of the elements of each type.

The QUEST method is an abbreviation of the English phrase Quantitative Utility Estimates for Science and Technology, which means "quantitative assessments of the usefulness of science and technology". This method was developed to improve the efficiency of resource allocation decisions allocated to research and development. The method is based on the idea of allocating resources on the basis of taking into account the possible contribution (method of expert assessment, which is determined) of different branches of technology and research in solving a certain range of tasks. The QUEST method involves the following steps:

– quantitative expert assessment of the significance of various tasks;

– quantitative expert assessment of the possible contribution of different branches of technology in solving problems, both in the case of regular funding and in the case of additional funding of relevant industries;

– determination of the total significance of each branch of technology for solving the whole set of tasks, which is carried out by summing the products of the significance of different tasks and the corresponding estimates of the contribution of this branch;

– distribution of resources between different branches of technology according to their total weights.

The peculiarities of the QUEST method are the involvement of a wide range of highly qualified specialists working in various fields of science and technology, as well as the provision of reliable, diverse and relevant information to experts.

To improve the efficiency of decision-making processes in the field of long-term scientific and technical orientation of a large industrial company, the PATTERN method was developed (an abbreviation of the English phrase Planning Assistance Through Technical Evaluation of Relevance Numbers, meaning – "planning assistance with relative technical evaluation indicators").

The essence of the method is based on the formulated goals of the consumer of the company's products for the forecast period, the deployment of some multilevel hierarchical structure, which is called the goal tree. For each such level, a number of criteria are introduced, and with the help of expert assessment, the weights of the criteria are determined, as well as the coefficients of significance that characterize the importance of the contribution of objectives to the criteria.

The significance of a goal is determined by the relationship coefficient, which is the sum of the products of the weights of the criteria to the corresponding coefficients of significance. The overall correlation coefficient of a goal (in terms of achieving a higher level goal) is determined by multiplying the corresponding coupling coefficients in the direction of the top of the tree.

The SEER method – System for Event Evaluation and Review was developed and applied for forecasting purposes in the field of information processing technology. This method eliminates some disadvantages of the Delphi method, namely:

– a large number of consecutive repetitions of assessments by experts;

– the need for the expert to repeatedly review their own answers, which causes the experts to react negatively.

The SEER methodology provides for two rounds of assessment, which significantly reduces the time of examination.

The Delphi method or the "Delphic oracle" method is an iterative questionnaire procedure and, in contrast to the traditional approach to reaching a consensus of experts, through open discussion, involves a complete rejection of collective discussion. This method requires the absence of personal contacts between experts and providing them with complete information on all evaluation results after each round of the survey, while maintaining the anonymity of evaluations, arguments and criticism. This is done in order to reduce the influence of such psychological factors as joining the opinion of the most authoritative specialist, unwillingness to renounce a publicly expressed opinion or following the opinion of the majority.

In the Delphi method, direct debates are replaced by a carefully designed program of consecutive individual surveys, which are usually conducted in the form of questionnaires.

The experts' answers are summarized and, together with new additional information, are made available to the experts, after which they clarify their initial answers. This procedure is repeated several times in order to achieve an acceptable convergence of the set of opinions.

The main advantage of the Delphi method is that any expert receives information that is available to the entire team of experts, and can clarify their own assessment.

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Based on the analysis of existing methods of examination, which are most used in practice, and consider the specifics of individual enterprises, we propose a combined method (Fig. 4), which allows to take into account the positive aspects and eliminate the shortcomings of some methods of examination.

The main emphasis of the proposed method – the examination takes place in three rounds. Experts of the first two rounds are practitioners (managers of middle and lower levels of government) of enterprises. The first two rounds are based on the Delphi method.

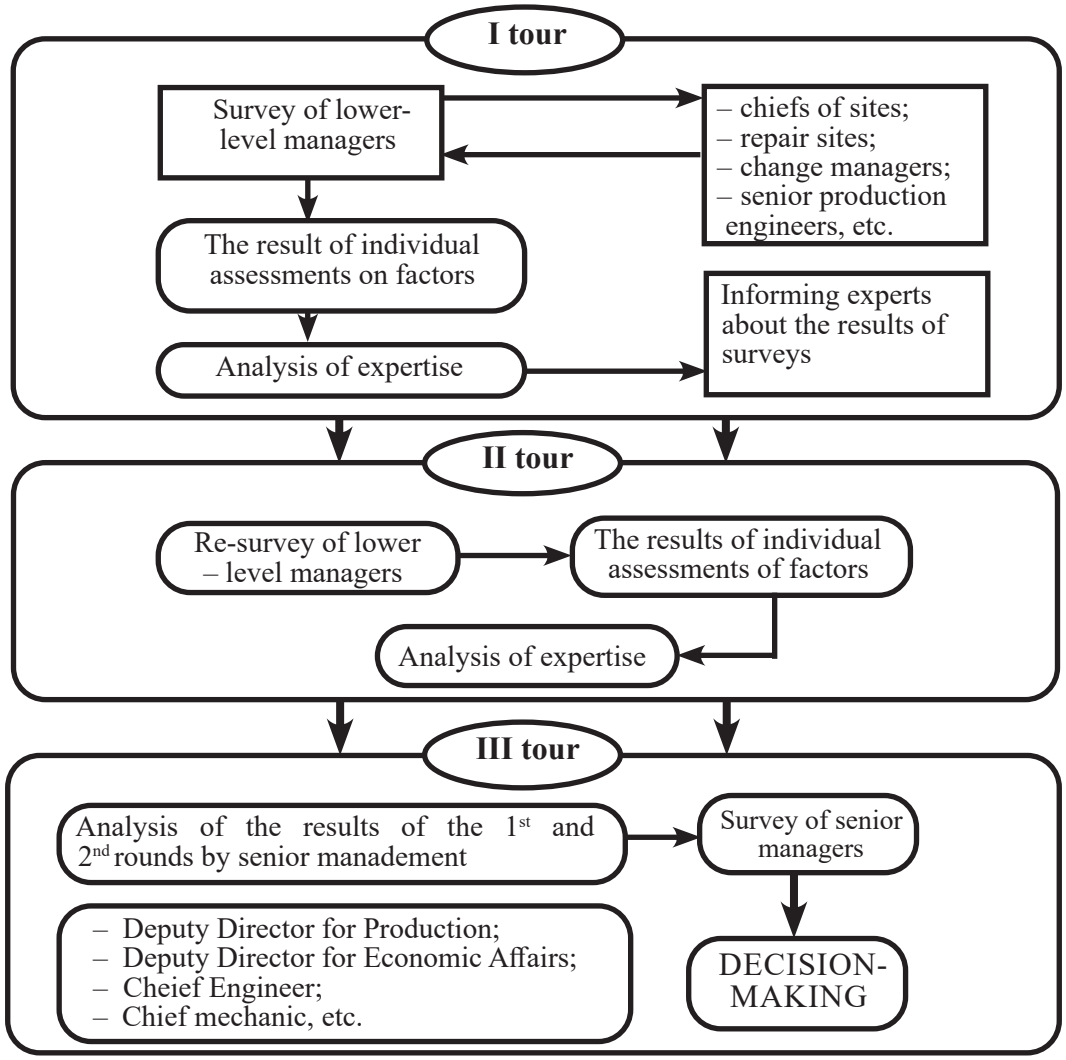

Figure 4 – Algorithm of examination

Each expert provides an individual assessment of the factors, based on their experience and the information provided to them. Experts are usually interviewed in the form of questionnaires. Experts provide answers without arguing them. Then the results of the polls are processed and the collective opinion of a group of experts is formed, arguments in favor of different opinions are identified and generalized.

Statistical processing of estimates is provided, the results of which are given to experts for use in the next round of surveys.

The expert of each round does not return to the consideration of his answers, except the cases when his answer falls out of the interval where there are most of the estimates. Thus, the expert can adjust his opinion by getting acquainted with the opinions of other experts.

Third-round experts are decision-makers, usually top management.

Conclusions. The proposed methodology, which covers all production units and levels of management of enterprises with specific production conditions, will allow you to quickly and adequately determine the issues that require a qualified solution.

Expert analysis of complex problems includes five stages – construction of a heuristic model, statement of the expert analysis, carrying out interrogation and reception of estimations, processing of expert estimations, interpretation of results of examination.

Among the main classes of modern tasks, where expert assessments can be used, we can also note the following: structural analysis – analysis of production, market structure, sales channels, market conditions, society, etc.; quality analysis – the quality of products, projects, personnel, knowledge, decisions, etc.; assessment of consequences – decisions taken, consequences of catastrophes, accidents, environmental pollution, conflicts, etc.; assessment and allocation of resources – credit policy, budget allocations, development of natural resources, etc.; strategic planning – long-term planning of companies, public services, large complexes, industries, etc.; policy development – financial, foreign economic, tax, technical, etc., those issues that are within the competence of the highest level of government.

Conflict of Interest and other Ethics Statements

The authors declare no conflict of interest.

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ПІДХОДИ ДО РОЗВИТКУ КОМПЛЕКСНОГО МЕТОДУ ЕКСПЕРТИЗИ НА ПІДПРИЄМСТВАХ

Анотація. У статті звертається увага на те, що для прийняття обґрунтованих рішень необхідно опиратися на досвід, знання та інтуїцію фахівців. Зазначається, що існує велика кількість методів щодо отримання експертних оцінок, використання яких має свої особливості та умови.

Методи проведення експертизи також відрізняються, в одних з експертом працюють окремо, в інших проблема обговорюється колегіально, вивчається думка інших експертів, невірні шляхи вирішення відкидаються. Також підкреслюється, що існує і різноманітність на всіх етапах проведення експертизи: формування групи за чисельністю, кваліфікації експертів. Використання статистичної обробки даних також суттєво відрізняються від математизованих до комп'ютеризованих. Надано основні методи і етапи експертного оцінювання. Акцентується увага на оцінках, їх класифікації за різними критеріями та ознаками. Зазначаються умови вимірювання якісних та кількісних характеристик та основні вимоги, що пред'являються до них. Звертається увага на умови використання шкали інтервалів і шкали порядків. Описується методика роботи експертів у випадку визначення ймовірнісних експертних оцінок. Описуються особливості використання методів, які найчастіше використовуються на практиці, серед яких: метод академіка В. Глушкова, морфологічний метод, методи QUEST, PATTERN, SEER і метод Дельфі. Запропоновано комбінований метод проведення експертизи на підприємствах зі специфічними умовами роботи. Розроблено алгоритм проведення експертизи та визначені основні її етапи проведення, а також функції осіб, що приймають участь у експертизі. Виокремлено основні вимоги до автоматизованої експертної системи.

Keywords: *експертиза, метод, оцінка, класифікація, етапи, експерти*

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