MAJOR OBJECTIVES FOR FORMALIZATION OF PREPARATION PROCESSES AND COLLECTIVE EXPERT DECISION MAKING

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One of the major theoretical and applied problems of the current stage system analysis development is to create a common effective regulatory system for decision making and formalization of its procedures. It is conditioned by the fact that any decision making is an essential and integral part of a purposeful human activity. Another aspect is that in the context of widespread and intensive use of computer technology as a tool of intellectual activity automation, formalization of decision making processes defines to a great extent prospects for information management system development, their effectiveness and intellectualization.

While carrying out administrative tasks in economic, manufacturing, engineering, technical, promotional and other activities, it is mandatory to consider a growing number of different factors. In these circumstances one person can not make a decision on the choice of factors conducive to goal achievement, can not identify essential interrelation between goals and means. In such a case a team of experts consisting of specialists in various fields of expertise should participate in decision making process. The problem of preparation and decision making in management of complicated projects and processes is the problem of collective decision making.

At the same time, the results of collective decision making depend strongly on the quantitative and qualitative composition of the expert group, the mode of its formation, professional homogeneity, constancy of the composition and form of receiving information, as well as its processing.

Effective use of export information depends on the accuracy and validity of the methods used [2, 3]. Expert estimates are necessary information in making sound and well-reasoned decisions, mainly in complicated situations. Often decisions are made by “trial and error”; therefore they may be non-optimal, ineffective and even have catastrophic consequences. To avoid this, it is necessary to know and follow the exact technology for development of collective decision making.

1. Analysis of research and publications. Methods for preparation and decision making based on the experience of expert teams of professionals emerged and evolved as independent. For generalization in the theory of systems, initially they were called qualitative or expert, because they represent approaches, in some form or another, activating detection and synthesis of the views of experienced professional experts [4]. However, there is a special class of methods associated with direct survey of experts, called the method of expert assessments [5]. This method is used by specialists when they can not immediately describe the problem situation under consideration with analytical

dependences or choose a method for forming a formalized presentation of the decision making model.

Quite a number of works study opportunities and peculiarities of expert assessments, for example, [7–10]. They consider the forms of expert estimation (different types of surveys, interviews, group discussions), different approaches to assessing (ranking, rationing, various types of regulation), methods for processing of survey results, requirements for experts and formation of expert teams, assessment of their competence (when considering experts' assertions, factors of their competence are introduced and allowed for, the probability of their opinions), methods for organizing export interviews [11]. In particular, B.G. Litvak [8] gives a detailed description of the principles and methods based on the choice of different modes of regulation and preference patterns: the methods for ranking and hyper-regulation, methods for paired comparison of Churchman, Ackoff, Thurstone, the mixed alternative method of Neumann–Mergenshtern, method for Arrow alternative discard, the algorithms for finding Kemeny median, metrized ranking, algorithms for selection in Pareto principle, the methods for determination on the set of multidimensional alternatives etc. [6].

A variety of application areas makes the applicable expert estimation mechanism sufficiently diverse and flexible. However, experience shows that at actual use of collective expert assessments it is far from always possible to follow the most applied schemes [4, 5, 12]. The purpose for the use of expert assessment technologies is preparation and making an effective collective decision, that is why a creative approach to the organization and execution of the expertise is essential for its leading specialists [10].

The problems of collective expert assessment were given consideration in some extent by Litvak B.K. [8], Emelyanov A.O. [7], Gnatienko G.N. [10], Pospelov D.O., Popov E.V., Kovalenko I.I., Mirkin B.G. [13–16], Jackson P., Waterman D., Churchman J., Ackoff R., Arrow K. [17–20], etc.

In 1951 K. Arrow did analysis of possible rules for collective decision making and formulated the following theory: if a collective rule for decision making meets certain natural conditions, then it is dictatorship. K. Arrow was awarded for the research in this area with the Nobel Prize.

The prospective idea for development of expert assessment methods proposed by V.M. Glushkov [21] is to combine a targeted multi-staged survey with the deployment of the problem in time that is quite feasible due to algorithmization of this procedure and computer usage.

Among recent publications there should be indicated the works [22–26], as well as the work [10], which provide detailed retrospective review of formalized expert estimation.

2. Statement of the problem. Collective expert assessment is one of the basic ideas for scientific research and an essential condition for qualitative confirmation of scientific results obtained. However, the present state of collective expert estimation, as a research area, requires further development of

its scientific approaches and methods for expert estimation. It applies to all aspects of the area: conducting psychological research aimed at reasoning of the most stable procedures for extracting and reporting intelligent information; structuring of processes and objectives for collective expert estimation, formalization of these processes, methodology for expert groups – research teams conducting expert estimation; improvement and development of qualitative and quantitative methods for estimation of processes and phenomena, methods and ways of decision making support-expert estimation results.

3. Statement of the basic material. It is critical for the experts, conducting the estimation, to approach its organization intelligently and creatively that will provide an adequate assessment of the object under study, choose feasible and leading to the aim decisions, and select among those the most acceptable and, if possible, the most effective one. Collective expert assessment (EA) is done based on consideration of a set of factors that are to be classified and regarded for linkage.

Formation, generalization and finalization into the whole of theoretical statements for collective decision making usually start with consideration of the problem structuring. Structuring of any problem can be shown in a generalized scheme of preparation stage sequence, solution and implementation of decisions (Fig. 1) [27].

Implementation of decisions can be preceded by motivation, adaptation of decisions, their adjustment and etc. (Fig. 2).

Formally, procedures of preparation and adaptation of expert assessment can be structured into a certain number united interrelated stages. Fig.3 shows a set of interrelated stages for a single expert assessment lifecycle in the sequence their implementation and application.

The structure pattern given arranges procedures for collective EA , simplifies and enhances understanding of expert estimation processes, systematizes knowledge on the methodology of expert assessment [28].

4. Preparation for collective expert estimation. By preparation for collective expert estimation we mean analysis and diagnosis of the problem, preliminary by-stage development of conceptual examination scheme, formation of requirements for examinations to ensure a selection of the specialists' team-experts for a problem solution in the area.

The process of preparation and expertise organization requires solution of a range of more or less complex problems. Some of them are purely technical in nature (their solution depends on business skills of people in charge of preparation and expertise organization). Others are determined by conditions of a specific expertise (for example, by particular features of the institution where it is held), emerge in certain cases and do not do in others, i.e. are not common enough. There are two circles of objectives that are fundamental and common in nature for every expertise – formation of expert teams and running collection procedures of expert information.

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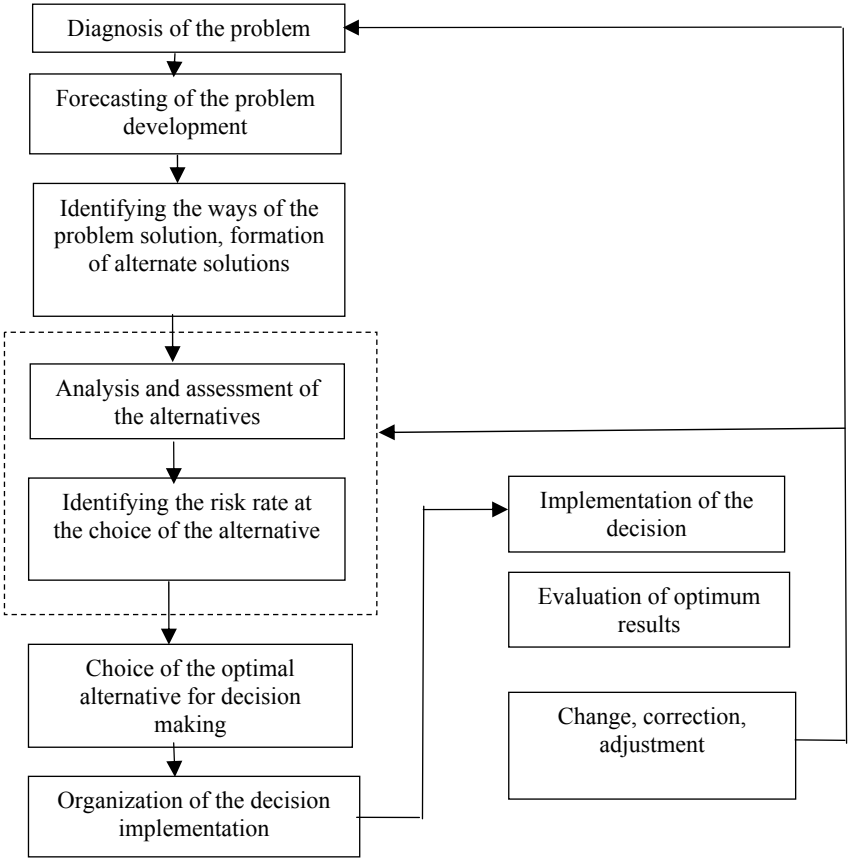

Fig. 1. Sequence of preparation, solution and implementation of decisions on any problem under study

Others are determined by conditions of a specific expertise (for example, by particular features of the institution where it is held), emerge in certain cases and do not do in others, i.e. are not common enough. There are two circles of objectives that are fundamental and common in nature for every expertise – formation of expert teams and running collection procedures of expert information.

Formation of requirements for expertise and subsequent selection of experts–specialists is an essential, if not the most essential, objective for preparation of collective methods and decision making.

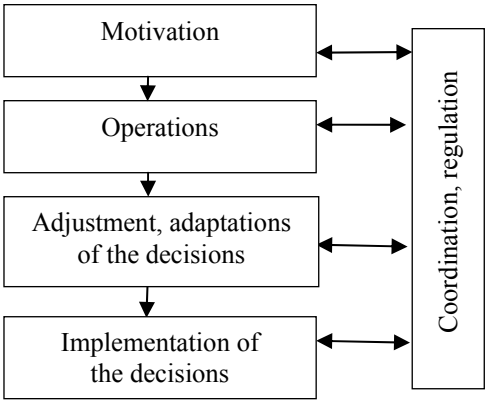

Fig. 2. Implementation of decisions

A pioneer in application of collective expertise methods, Perov A.S. stated that if someone assumes responsibility for fulfilling all the operations on organization of an expertise, questioning experts, processing assertions, and he is only required to select experts, he will agree to do an expertise for any pre-assigned outcome. This remark is not a jest. Appropriate selection of experts can provide the desirable result, and the procedure for expert selection will seem rather believable and convincing [29].

Let us recall two well-known examples from history. During World War II, the president of the USA F.D. Roosevelt, facing the Congress demand to establish CIA, and not willing to create such an organization, formed “an expert team” of apparently the most competent specialists in intelligence – staff heads for different corps. That team was to solve the problem of unification of intelligence under general leadership. As F.D. Roosevelt expected, the team made a persuasive reasoned decision on inexpediency of creating CIA. Meanwhile, in fact, their position was determined by reluctance to transfer intelligence from their own to other hands.

Another example of truth falsification, carried out by means of “collective expertise”, – “Burdenko Commission” investigation on the authorization of the execution of several thousands of Polish officers. The world community accused of the shooting the soviet authorities. N.N.Burdenko, a famous surgeon, led the “expert team” consisting of Metropolitan Nikolai, the writers Alexey Tolstoy and Vanda Vasilevskaya, the historian E.V.Tarle, the aviatrix V.S. Grizodubova, the USA ambassador’s daughter, a journalist Katty Garriman and other prominent persons, the very presence of whom was to make the investigation respectful and credible.

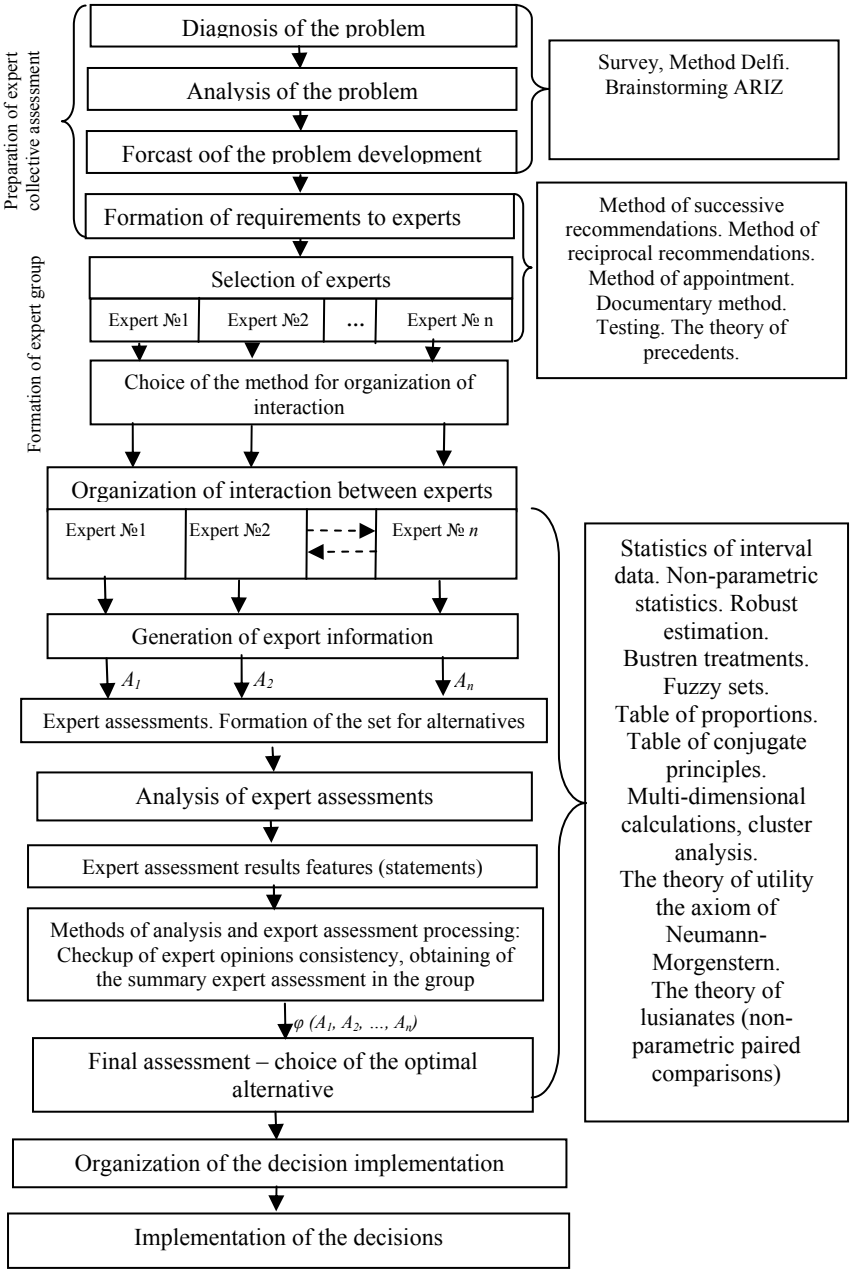

Fig. 3. Structuring of the life cycle for preparation and collective decision making

The major question, the commission had to answer was – the time of shooting as exactly the time defined the "authors".

What knowledge did those "prominent" persons have to judge about the time span of the burial. If the commission members had managed to determine the term, could they have been able to state and make public their assertions? It is evident, that the outcome of the commission work was defined by those who had formed it at the moment of its creation. As for N.N. Burdenko – the only one who could not mistake in determining the date of the shooting – he was soon given by the Soviet government the position of the president of an especially created Academy of Medical Sciences of the USSR. As it is known, Russia has submitted declassified documents that reveal that the polish officers were shot by Soviet authorities.

5. Formalization of processes for expert team formation. Researchers consider that of all the objectives related with conduct of expertise, the formation of expert teams is the least worked out due to subtle psychological and social factors.

In contrast to the established theory for professional selection [30], the objective for competence estimation of candidates in expert selection is modified. The expert team should not be homogenous; there must be a leader, a generator of ideas, a critic, and a librarian. In the terms of expertise objectivity, team experts should be loyal to the final result. There are difficulties at an expert team formation in determination of a particular expert team size, accuracy of assessments obtained, and consistency of expert opinions in the group. It is not always easy to identify the whole set of specialists – experts in the issue under consideration, especially in new or adjacent areas of knowledge. And both an individual expert and an expert team (ET) should be determined by the following features: competence, creativity, attitude to expertise, conformism, broad-mindedness, analyticity, collectivism.

6. Formalization of the processes for expert group formation is an essential stage in the formation of the general theory of collective decision making. The process of formation of expert team can be shown in the following way (Fig. 4).

Formally the statement of the problem of expert group formation can be shown the following way [28]. Suppose that:

$Q = \{q_1, q_{2,}, \ldots, q_n\}$ – a set of precedents for expert team;

$A = \{a_1, a_2, \ldots, a_m\}$ – a set of functions that can be done by the team.

Each candidate is characterized by a set of qualities:

$L_{Q_i} = \{l_1, l_2, \ldots, l_k\}$ and the ability to perform the functions: $F_Q = \{f_1, f_2, \ldots, f_t\}$.

$K = \{k_1, k_2, \ldots, k_q\}$ – the set of given factors of reservation for the corresponding factor.

The reserve factor determines the minimum necessary number of experts able to implement the function for ensuring the expertise and preparing

management solutions. Abilities of candidates to an expert team are summarized in Table 1.

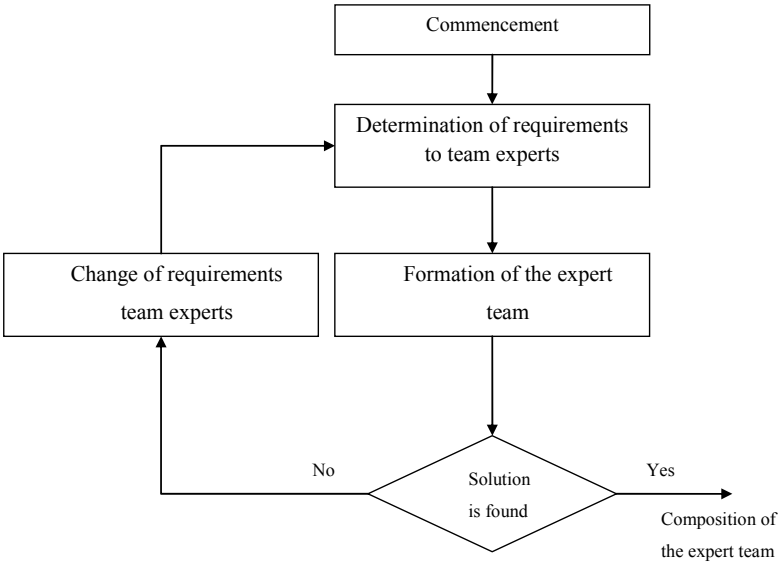

Fig. 4**.** The process of expert team formation

Table 1. Abilities of candidates in performing corresponding functions

A / Q	a_1	a_2	…	a_m
q_1	R_{11}	R_{12}	…	R_{1m}
q_2	R_{21}	R_{22}	…	R_{2m}
	…	…	…	…
q_n	R_{n1}	R_{n2}	…	R_{nm}

R_{ij} – matrix element $(n \times m)$, that shows candidates' abilities to perform corresponding expertise functions (Table 1). If i–candidates able to perform j–function, then $R_{ij} = 1$, otherwise $R_{ij} = 0$.

Thus, to select from a number of candidates a team of experts $D = \{d_1, d_2, ..., d_i\}$ ($d_i = 1$, if i–candidate is a team member, and d_i=0 otherwise). It is necessary to determine a sub-set of minimum costs ($\sum_{i=1}^{n} (d_i \cdot c_i) \rightarrow \min$) for any function (task) belonging to the function set of the team. Where c_i – costs of

engaging i–specialist. It is implied that the team expert number capable of performing this function (task) must satisfy task requirements of reserving functions $\sum_{i=1}^{n}\left(d_i R_{ij}\right) \geq k_j$.

Formation of expert team based on theory of precedents. Understanding of broad opportunities of models and methods for reasoning based on precedents has led to creation and rapid development of the "theory of precedents" known as Case–Based Responding (CBR) – a method of reasoning based on precedents. Database management systems, specialized knowledge servers, Data Mining, OLAP models etc. can operate as the precedent base (PB). The situation that served as the base to a precedent further is considered as a base situation and is kept in the PB. Models and instrumental methods for implementation of the precedent method create a support system of precedent decisions SSPD (Fig. 5).

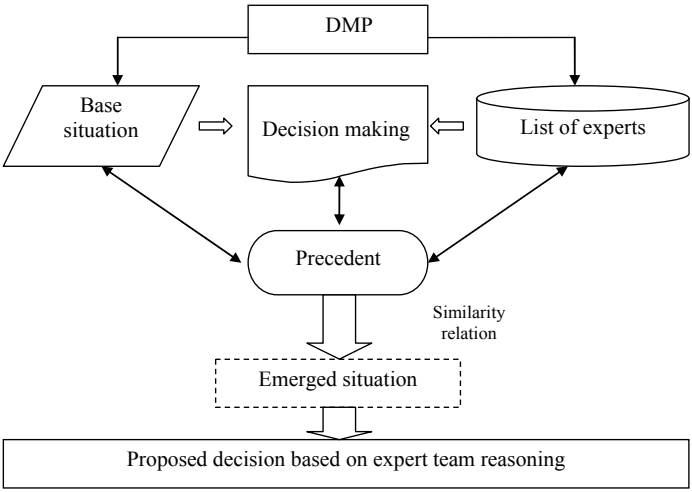

Fig. 5. Collective (expert) decision making based on precedents.

Many precedent based systems extract from PB only the most relevant precedents and leave the adaptation process for DMP or the expert team. When a need for creation an expert team occurs, DMP selects the candidates who participated in the expertise on similar issues and forms a list of experts. The algorithm of ET formation can follow the following steps:

Step 1: Identification of the project is done (analysis of structure problems of the research), definition of key indicators of the project.

Step 2: The limit on the number of exports in ET is specified.

Step 3: The DB of PB storage is referred.

Step 4: Search for the optimal decision in DB of precedents: description of the current situation in the subject area and identification of obtained descriptions of terms in existing categories; creation of the situation description in the language of its presentation; search for a sample situation within the vicinity interval set; narrowing the search by including attributes of object notions; optimization of the search process for optimal selection of candidates.

Step 5: Selection of ET candidates (projects in which the candidates participated were successful).

Step 6: Correction of the screened expert list by applying a modified documentary method.

Step 7: Formation of a new ET by the DMP and recording in DB of precedents if no coincidences are found.

Formation of a new expert team based on the theory of precedents is shown in Fig. 6.

Formation of a standard variant of an expert model can also be achieved through the use of the theory of precedents:

A standard variant of an expert model for ET is given as a cortege U^t (1) for further formation of selection criteria by the method of precedents:

$$U^t = \left\langle \left\langle u^t_{lt}; u^t_{stg}; u^t_{pub}; u^t_{vst}; u^t_{dl}; u^t_{us}; u^t_{zv}; u^t_{pt} \right\rangle; \left\langle u^t_{sam} \right\rangle; \left\langle u^t_{usp} \right\rangle; \left\langle u^t_{imn} \right\rangle \right\rangle, \ t = \overline{1,n}, \qquad (1)$$

or as an associative contraction (2)

$$U^t = \left\langle \begin{matrix} k_1 u^t_{lt} + k_2 u^t_{stg} + k_3 u^t_{pub} + k_4 u^t_{vst} + k_5 u^t_{dl} + k_6 u^t_{us} + k_7 u^t_{zv} + \\ + k_8 u^t_{pt} + k_9 u^t_{sam} + k_{10} u^t_{usp} + k_{11} u^t_{imn} \end{matrix} \right\rangle, \qquad (2)$$

Where for t–expert: u^t_{lt} – expert age; u^t_{stg} – length of work in a «problem area»; u^t_{pub} – the number of publications in the area; u^t_{vst} – the number of speeches, related to the problem solution; u^t_{dl} – the position taken; u^t_{us} – scientific degree; u^t_{zv} – academic title; u^t_{pt} – the number of patents, certificates (related to the problem under study); u^t_{sam} – competence self-assessment; u^t_{usp} – the number of successfully implemented projects; u^t_{imn} – expert reference given by other experts; $k_1, k_2, \ldots, k_{11}$ – weighting factors; n – the number of experts in the base.

The model of the standard variant for selection of experts in a ET is described by expression (1). The necessary condition is limiting by weighting factors, and the total value (2) for the standard expert must approach unity.

Complex assessment (2) is a simplified variant of quality estimation of individual experts for ET and their formation for the precedent database.

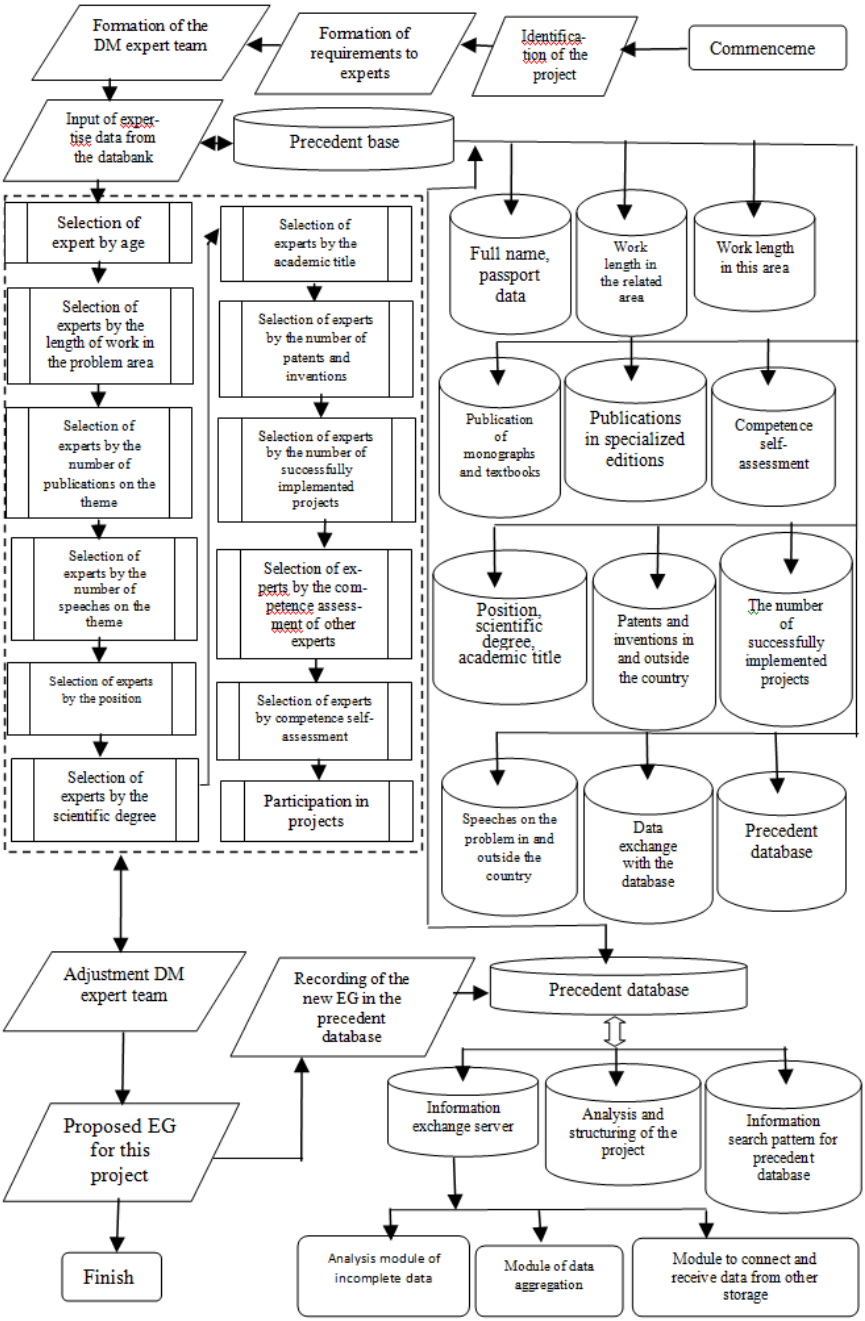

Fig. 6. The process of expert team formation

7. Conclusions. The work outlines structures and systematizes the main stages and objectives for collective expert assessment in decision making. For the first time is the method for formation an expert team suggested (ET), based on creation information base of previous developments that, unlike the existing ones, uses the precedent theory. The algorithm for ET formation is worked out. It is proposed to use a standard expert model in forming ET based in CBR.

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