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Hardware-software complexes for evaluation of competence level of experts

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Abstract
The algorithms and composition of programmatic-instrumental complexes for the evaluation of competence level of experts that are based on the Analytic Hierarchy Process and with the account of uncertainties of data are considered. For the quantitative evaluation of competence of experts in the offered complexes the special criteria are used with their point evaluation. The offered complexes are designed to forming of the most qualified groups of experts for the group expert evaluation of the most essential problem questions in different fields of activities.
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For the solution of set tasks and making decision in the different fields of activities it is expedient to attract experience and qualified experts on marked fields. Expert evaluation, up to a point, necessary even when to the set of the obtained data classic statistical methods can be used, as an expert can judge about that, or there are these data by a representative random sample and, if it so, then what method to use for the analysis of these data [1-4].

Efficiency of expert evaluation substantially depends on the competence of those, who participate. The increase of reliable of expert's competence evaluation is assisted by development of both algorithm of such evaluation and formulation of going near prognostication of this evaluation for realization of the necessary setting of norms of expert competence. Having regard to it, it is possible to consider the theoretical ground of choice of forming method of expert groups and selection of the most qualified experts and development of approach the basic questions of upgrading of expert evaluation for setting of norms of expert competence in certain activities.

Let us distinguish the subjective and objective approaches for selection of experts [4]. Objective approach assumes the use of special methods of selection. The variety of objective approach is documentary approach that envisages the selection of experts on the basis of their social-demographic data. On the whole, it is necessary to notice that present approaches cannot in a complete measure simply decide a question in relation to the selection of experts that is the methods of such selection must be based on combination of different approaches.

In [5] the offered method (methodology) of competence evaluation of experts is on the basis of theory of fuzzy sets. On the basis of realization of such method a tool and offered methodology that allows carrying out of competence evaluation of experts on the basis of unclear relation of advantages are created. A database the results of questioning of experts are kept in that enters in the complement of tool.

The lacks of the considered method and corresponding tool are the uses of relation between the finite set of competences that characterize the states of object of individual evaluation, and descriptions, that a certain expert, and calculation of degree of divergence, offers between the set requirements to the expert and certain coefficient of competence that narrows an application of this approach domain. Its realization is the establishments of the marked divergences related to considerable difficulties. Forming of the most qualified group comes true for the identical level of competence that narrows an application of this approach domain also.

In [6] methodology of competence evaluation of experts is offered on the basis of Analytic Hierarchy Process (AHP) [7]. A methodology belongs to the field of comparative evaluation of competence level of experts in various fields of activities and qualified forming of expert group of certain competence. It is expedient to apply as useful instrument for the comparative evaluation of competence of experts on the basis of their objective data on the set criteria for the different fields of activities and family or contiguous fields of activities, and also for determination of dynamics of competence increase after some years for every expert.

In general case, a list of criteria must be such, to represent maximally all-round the competence level of expert. Every competence criterion of expert can be appraised with the use of data in relation to education, to experience in the field of certain activity in certain position and other accessible information.

A task in relation to determination of expert competence with application of AHP decides by means of three hierarchical levels: the first (overhead) level of hierarchy answers the aim of task – to define the competence of experts; the second level contains criteria after that the expert competence is determined; at third (lower) level is an expert (expert group), the competence of that is necessary to be defined or compared.

The result of realization of the offered method is a quantitative evaluation of expert competence by means of establishment of necessary of competence level with the use of AHP that allows: to promote reliable of expert evaluation and carry out a heel and form the most qualified group of experts.

Essence of this methodology consists in: 1) set the competence criteria for expert evaluation for research of certain object;

2) carry out insertion of objective data on the set criteria for the set of experts the competence of that is compared;

3) construct the matrix of pairwise criteria comparison and the most own number, characteristic of consistency and relation of consistency, determine it;

4) carry out verification of satisfaction of relation of consistency to the set requirements in relation to criteria with application of the set of consistency characteristic;

5) construct the matrix of pairwise comparisons of every compared expert and the rationed own vectors, most own numbers, characteristics of consistency and relation of consistency, determine it; 6) carry out verification of satisfaction of relation of consistency to

the set requirements in relation to experts with application of the set of characteristics of consistency;

7) determine global priorities for each of the compared experts;

8) rank got global priorities (value of competence) for each of the compared experts in the order of increase of values;

9) form the group of experts taking into account the got global priorities for realization of expert research of certain objects.

The algorithm of evaluation of expert's competence on AHP methodology is brought around to Figure 1 [8].

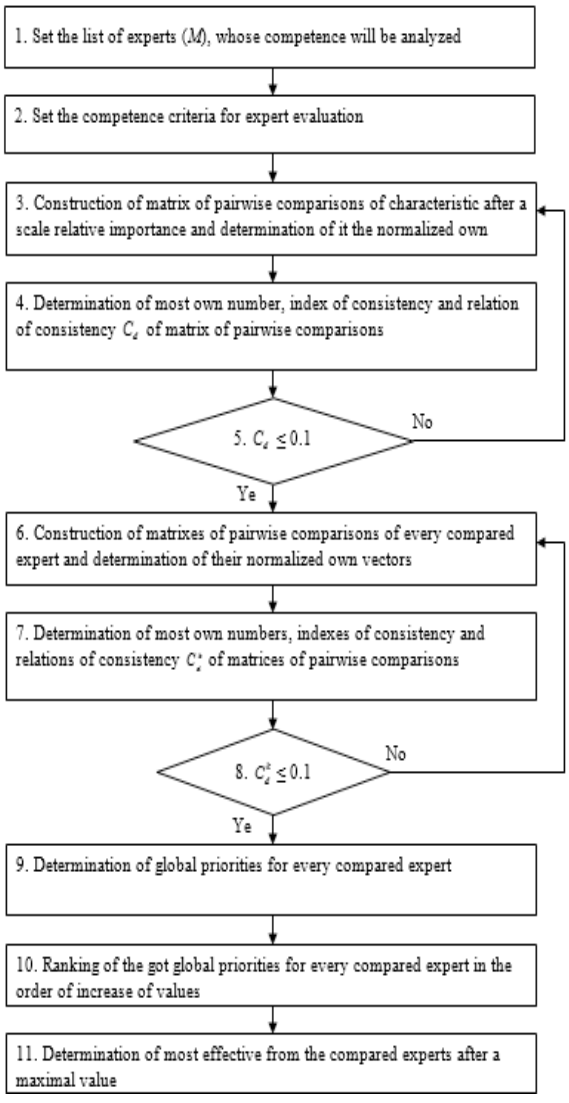

Figure 1. Algorithm of evaluation of expert's competence on AHP methodology

The flow diagram of the special hardware-software complex for realization of the considered methodology of competence evaluation of experts on the basis of AHP is brought around to Figure 2, where:

1 – module of task of set of competence criteria of expert for research of certain object and its numerical values;

2 – module of insertion of objective data on the set criteria for experts the competence of that is compared;

3 – module of construction of matrix of pairwise comparisons of criteria;

4 – module of determination of most own number, index of consistency and relation of consistency of matrix of pairwise comparisons;

5 – module of verification of satisfaction of relation of consistency to the set requirements in relation to criteria;

6 – module of set of consistency indexes;

7 – module of construction of matrices of pairwise comparisons of every compared expert;

8 – module of determination of the normalized own vectors, most own numbers, indexes of consistency and relations of consistency of matrix of pairwise comparisons of every compared expert;

9 – module of verification of satisfaction of relations of consistency to the set requirements in relation to experts;

10 – module of determination of global priorities for each of the compared experts;

11 – module of ranking of the got global priorities (values of competence) for each of the compared experts in the order of increase of values;

12 – module of forming of expert group taking into account got global priorities.

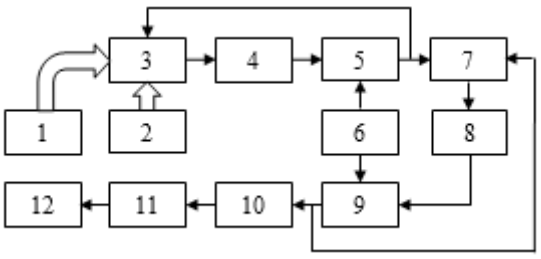

Figure 2. Hardware-software complexes for realization of the considered methodology of competence evaluation of experts on the basis of AHP

By the module 1 there set the set of competence criteria of expert for research of certain object. In the module 2 there carried out insertion of objective data on the set criteria for the set of experts, whose competence is compared.

By means of the module 3 there carried out the construction of matrix of pairwise comparisons of criteria, and module 4 is determining of its most own number, index of consistency and relation of consistency. In the module 5 verification of satisfaction of relation of consistency comes true to the set requirements in relation to criteria with application of set of

indexes of consistency that is kept in the module 6.

By means of the module 7 there carried out the construction of matrix of pairwise comparisons of every compared expert, and module 8 is determining of it the rationed own vectors, most own numbers, indexes of consistency and relations of consistency. In the module 9 verification of satisfaction of consistency relation comes true to the set requirements in relation to experts with application of set of indexes of consistency that is kept in the module 6.

In the module 10 determination of global priorities comes true for each of the compared experts; in the module 11 there is raking of the got global priorities (values of competence) for each of the compared experts in the order of increase of values, and in the module 12 there is the eventual forming of group of experts taking into account the got global priorities.

Application of such methodology and corresponding complex has certain limitations: data can be analyzed only to 15 experts that it is related to the known calculations of index of casual consistency R_c (Table 1) [8, 9]. For the eventual forming of group of experts there can be the applied principle of Pareto [9]. In this case the selection of group of experts will come true at more hard terms in relation to appraised competence.

Table 1. Index of casual consistency for AHP

M	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
R_c	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49	1.51	1.48	1.56	1.57	1.59

In [9] methodology of evaluation of competence of experts is offered taking into account descriptions of data uncertainties. For realization of the offered methodology, corresponding criteria are set for the ball evaluation of expert competence of certain activity. There offered special algorithm of calculation of row of mathematical characteristics for every expert, and also supporting value of evaluation and it general standard uncertainty. Methodology belongs to the field of comparative evaluation of level of expert competence in various fields of activities and qualified selection and forming of group of experts of certain competence.

The result of realization of this methodology is a quantitative evaluation of expert competence by means of establishment of necessary level of competence taking into account the data uncertainties, that allows: to promote consistency of expert evaluation and carry out a heel and forming of the most qualified group of experts.

Essence of this methodology consists in:

1) set the competence criteria for expert evaluation, which have objective characteristics of expert;

2) carry out insertion of objective data on the set criteria for the set of experts, whose competence is compared;

3) evaluate the set points of every expert from the certain set of experts on the all set criteria;

4) determine average points, relative average points and normalized average points numerical score for data of every expert;

5) calculate the reference point of evaluation and total standard uncertainty of evaluation for realization of general comparative evaluation of competence of experts;

6) carry out verification of average normalized points for every expert on consistency in obedience to a χ^2-criterion;

7) rank of got average normalized points for experts (values of competence) after reduction, casting aside average normalized points for experts that dissatisfy a χ^2-criterion;

8) form the group of experts taking into account the got results in relation to consistency of data on a χ^2-criterion for realization of expert research of certain object.

The algorithm of evaluation of expert's competence on methodology with taking into account the data uncertainties [10, 11] is brought around to Figure 3.

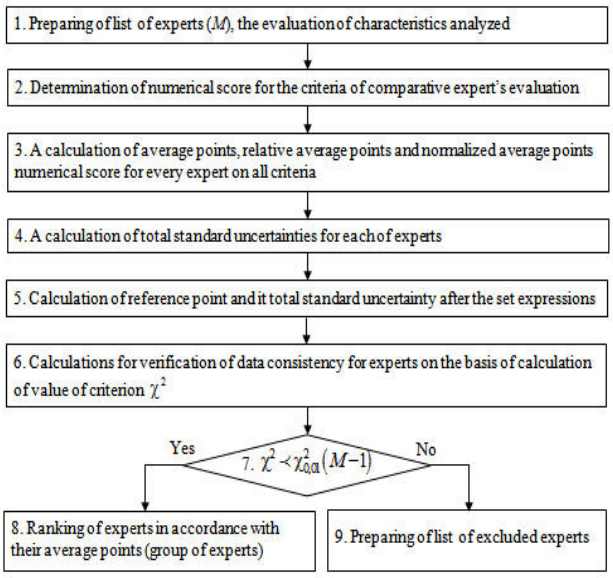

Figure 3. Algorithm of evaluation of expert's competence on methodology taking into account the data uncertainties

The flow diagram of the special hardware-software complex for realization of the considered methodology of competence evaluation of experts with taking into account the data uncertainties is brought around to Figure 4, where:

1 – module of task of set of competence criteria of expert for research of certain object and its numerical values;

2 – module of insertion of objective data on the set criteria for the set of competence experts that is compared;

3 – module of calculation of average points, relative average points, normalized average points numerical score and total standard uncertainty for data of every expert, reference value of evaluation and total standard uncertainty of evaluation;

4 – module of verification of normalized average point for every expert on accordance of χ^2-criterion;

5 – module of set of critical values χ^2-criterion;

6 – module of ranking of got normalized average point for experts (values of competence) after reduction with the casting-out of normalized average point for experts that dissatisfy a χ^2-criterion;

7 – module of forming of group of experts taking into account the got results in relation to consistency of data for realization of expert research of certain object.

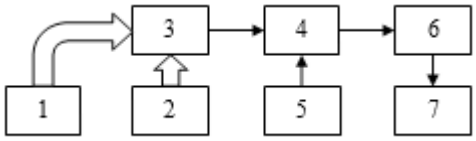

Figure 4. Hardware-software complexes for realization of the considered methodology of competence evaluation of experts with take account of data uncertainties

By the module 1 there set the set of competence criteria of expert for research of certain object. In the module 2 there carried out insertion of objective data on the set criteria for the set of competence expert that is compared. By means of the module 3 there carried out the calculations of average points, relative average points, normalized average points and total standard uncertainty for data of every expert, reference point of evaluation and total standard uncertainty of evaluation.

Modules 4 and 5 are used for verification of normalized average points for every expert on accordance of χ^2-criterion at comparing to the critical value χ^2.

After it by means of the module 6 there carried out rank of got normalized average points for experts (values of competence) after reduction with the cast ing-out of normalized average points for experts that dissatisfy a χ^2-criterion, and by means of the module 7 is the eventual forming of group of experts taking into account the got results in relation to consistency of data for realization of expert research of certain objects.

Application of such methodology and corresponding complex, without regard to its greater simplicity of realization in relation to considered another ways and facilities, does not have limitations in relation to the amount of experts objective data that are compared. For the eventual forming of group of experts except a χ^2-criterion can be applied also principle of Pareto [9]. In last case the selection of group of experts will come true at more hard terms in relation to appraised their competence.

Got by means of the considered methodologies and complexes of evaluation of competence level description for a certain expert allow more reasonably to carry out the selection of the most competent experts for forming of group from the evaluation of certain problem questions in certain fields of activities. It promotes reliability of evaluation of experts and allows forming more competent groups of experts and, as a result, getting more substantial expert evaluation on problem questions that are examined.

References

1. Litvak B. G. Expert estimations and making decision. Moscow, Patent, 1996, 271 p.
2. 2. Orlov A. I. Expert estimations. Moscow, 2002, 31 p.
3. 3. Grabovetskii B. E. Methods of expert estimations: theory, methodology, directions of the use. Vinnytsa, VNTU. 2010, 171 p.
4. 4. Gordiyenko T. B., Velychko O. M., Kolomiets L. V. (2014). A selection of experts for the methods of estimation in field of the technical regulation. Metallurgical and Mining Industry. No 2 (287), p.p. 90–92.
5. 5. Patent of Ukraine on an useful model № 85314. Method of evaluation of competence of experts. Malovik K. M., Vasilevich L. F. MPC G06F 17/18. 11.11.2013. Bulletin No 21.
6. 6. Gordiyenko T. B., Velychko O. M. (2014). Methodology of evaluation of competence of experts with application of Analytic Hierarchy Process. Metallurgical and Mining Industry. No 2 (287), p.p. 86–89.
7. 7. Saati T. Making decision. Analytic Hierarchy Process. Moscow, Radio and communications, 1993, 279 p.
8. Velychko O. M., Kolomiets L. V., Gordiyen-

ko T. B., Shevtsov A. G., Karpenko S. R., Gaber A. A. Group expert evaluation and competence of experts. Odesa, 2015, 285 p.
9. Velychko O. M., Kolomiets L. V., Gordiyenko T. B. Methods of optimization of the hierarchical systems in metrology and standardization: theory and practice. Odesa, VMV, 2010, 250 p.
10. Velychko O. M., Gordiyenko T. B., Kolomiets L. V. (2014). Methodology of estimation of expert's competence taking into account the of data uncertainties. Metallurgical and Mining Industry. No 3 (288), p.p. 135–137.
11. 11. Velychko O. M., Gordiyenko T. B., Kolomiets L. V. (2015). Methodologies of evaluation of expert's competence and group expert evaluation. Metallurgical and Mining Industry. No 2, p.p. 262–271.

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