

EVALUATION OF COMPETENCE OF THE EXPERTS IN FIELD OF METROLOGY AND INSTRUMENTATIONS

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Abstract – The different methodologies of competence evaluation of experts are considered. The results of quantitative evaluation of competence of the experts got by means of software tools are considered, based on different methodologies of evaluation.

Keywords: expert, competence, methodology, evaluation.

1. INTRODUCTION

In many fields of human activities of modern society conduct various expert evaluations with the aim of receipt of decisions in relation to overcoming of certain problem on the basis of opinion of the experts and further decision-making. It is necessary for the receipt of reliable evaluations, foremost, correctly to go near the selection of experts – skilled specialists that have the special skills or knowledge in concrete fields of human activity and that is attracted for research or realization of scientific and technical examination on certain questions [1, 2].

For the decision of set tasks and making decision in the concrete fields of activity it is expedient to attract experience and skilled experts on marked questions, that for today small enough. Expert evaluations, up to a point, necessary even then, 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. It can demand both technical and statistical evaluation. Interpretation is especially needed for the set of data, what small on volume or very skew.

On the basis of practical experience scientists tried to work out the receptions of selection of experts, in particular sufficiently difficult. In the special scientific and technical references in relation to expert evaluations the type of "ideal" expert, able to decide creative tasks, see and form unobvious problems, is actually represented, intuitively to do faithful conclusions, envisage the possible changes of the state of the investigated object, with independence of judgements and ability to see a problem from the different points of view. However, in practice to select of experts that would own similar properties, is difficult.

The methods of selection of experts are taken to two basic approaches: subjective and objective. Subjective approach envisages bringing in to procedure of selection of potential experts or scientific public from the environment of that they are taken away with application of method of

mutual evaluation or method of self-appraisal of level of competence and objectivity. Objective approach has, in turn, two variants: documentary and experimental. Objective approach assumes the use of the special methodologies of selection.

In any case one of basic criteria of selection of expert there is a level of his competence. A competence of expert is his ability to give reliable judgments about the object of examination on the base of professional knowledge, intuition and experience. Methodology of selection of experts that must be based on combination of different approaches in relation to their evaluation is necessary.

2. SPECIAL METHODOLOGY FOR EVALUATION OF THE EXPERT COMPETENCE ON AHP BASIS

With application of Analytic Hierarchy Procedure (AHP) [3, 4] it is possible to realize a few variants of evaluation of expert competence, in particular to evaluate: competence of any expert in concrete sphere of activity (for example, in field of metrology); dynamics of increase of competence level of experts after years for every expert separately.

A task in relation to evaluate of competence of experts with using of AHP decides by means of three hierarchical levels (Figure 1). The first (overhead) level of hierarchy answers the aim of task – to define the expert competence; the second level contains criteria after that the expert competence is determined; at third (lower) level is an expert (group of experts), the competence expert that is necessary to be defined or compare.

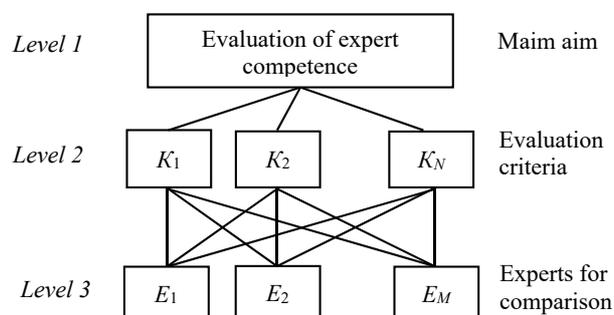


Fig. 1. Hierarchical levels for expert competence.

In general case, a list of criteria must be such, maximally all-round to represent the competence level of expert. Every criterion of expert competence 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. For relevant comparison during realization of evaluation of expert competence it is necessary to take all constituents that are compared into account. Every constituent of criterion is evaluated separately and pairwise comparisons and all other stages with application of AHP execute from criteria.

The algorithm of evaluation of expert competence for this methodology is presented on Figure 2. The numeral values of relative importance of constituents are set directly at every concrete implementation of comparative analysis of expert competence. Thus analyses the results of present data about experts that characterize their level after separate constituents and determined by the numbers.

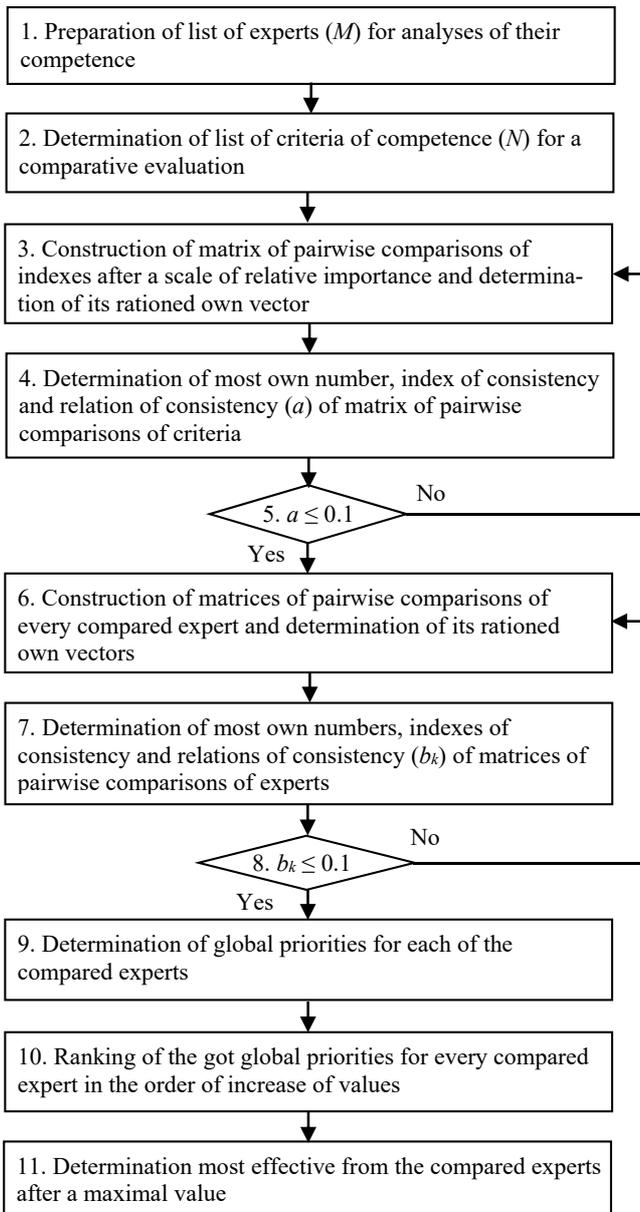


Fig. 2. An algorithm of evaluation of expert competence on AHP basis.

For realization of the offered methodology of evaluation of expert competence on AHP basis settle accounts:

- relation of consistency of matrix of pairwise comparisons of criteria

$$a = \frac{\sum_{j=1}^N \sum_{i=1}^N a_{ij} \cdot \left(\sqrt[N]{\prod_{j=1}^N a_{ij}} / \sum_{i=1}^N \sqrt[N]{\prod_{j=1}^N a_{ij}} \right) - N}{N-1} / R_c, \quad (1)$$

where: a_{ij} ($i, j = 1, 2, \dots, N$) are elements of matrix of pairwise comparisons of criteria; N is quantity of criteria; R_c is index of casual consistency tabbed depending on the dimension of matrix;

- relations of consistency of matrix of pairwise comparisons of experts for all criteria

$$b_k = \frac{\sum_{j=1}^M \sum_{i=1}^M b_{ij}^k \cdot \left(\sqrt[M]{\prod_{j=1}^M b_{ij}^k} / \sum_{i=1}^M \sqrt[M]{\prod_{j=1}^M b_{ij}^k} \right) - M}{M-1} / R_c \quad (2)$$

where: b_{ij}^k ($i, j = 1, 2, \dots, M; k = 1, 2, \dots, N$) are elements of matrix of pairwise comparisons of criteria; M is quantity of experts.

On the basis of the defined methodology are work out the software “Competence AHP 1.1” [5]. The environment of development of this software is Borland C Builder 6.0. Examples of data and results windows are presented on Figure 3 and 4.

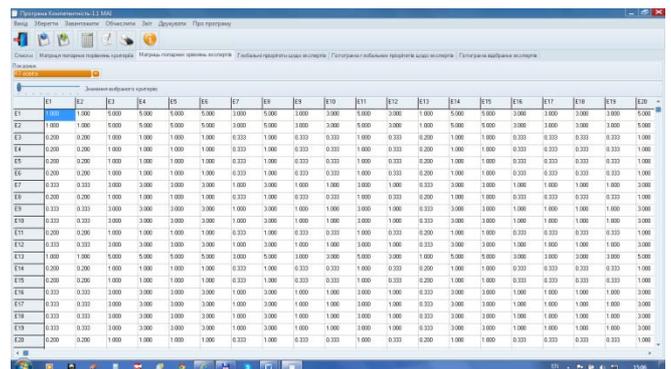


Fig. 3. Data window of software “Competence AHP 1.1”.



Fig. 4. Results window of software “Competence AHP 1.1”.

For the selection of experts Pareto chart (80/20) is used with using of Lorenz curve (80 % of cumulative sum of all values of indexes for experts that is compared). On results



Fig. 7. Results window of software “Competence UD 1.0”.

For the selection of experts Pareto chart is used with using of Lorenz curve. On results an evaluation seven experts has an unsatisfactory competence.

4. COMPARATIVE ANALYSIS OF ESTIMATION RESULTS OF EXPERT COMPETENCE BY DIFFERENT SOFTWARE

The competence evaluation 32 experts in field of metrology and instrumentations were conducted on the

specially worked out criteria. Quantitative evaluation of competence of these experts were appraised by means of as the specialized software “Competence AHP 1.1”, “Competence UD 1.0” [5], so universal statistical software (Microsoft Excel 2010, IBM SPSS Statistics 20) with using abundant statistical method and statistical characteristics [8].

All evaluation was done on the same criteria:

- K1 – education;
- K2 – general work experience;
- K3 – general experience in field of metrology and instrumentations;
- K4 – experience of expert in field of metrology and instrumentations;
- K5 – work position.

Comparison of competence evaluation results of the marked experts by means of different software is driven to the Table 1. Windows of the marked universal software with final evaluation results are shown on Figure 8 and 9.

On the got results from the general amount of experts that was evaluated, after the all applied software six experts were declined. Additionally software “Competence AHP 1.1” is decline five experts; by software “Competence UD 1.0” – one; by the Microsoft Excel 2010 – three; IBM SPSS Statistics 20 – one.

Table 1. Comparison of competence evaluation results.

Expert	“Competence AHP 1.1”		“Competence UD 1.0”		Microsoft Excel 2010		IBM SPSS Statistics 20	
	Global priority	Place	Normalized average grade	Place	Normalized average grade	Place	Average grade	Place
1	0.049	2	0.00431	1–3	0.98	3	8.6	3
2	0.023	21–22	0.00401	5–9	0.86	12–15	7.6	12–15
3	0.011	28–29	0.00284	28–29	0.61	28	5.4	28
4	0.046	9–10	0.00382	12–15	0.89	9–11	7.8	9–11
5	0.043	13	0.00382	12–15	0.86	12–15	7.6	12–15
6	0.015	25	0.00313	23–25	0.66	26	5.8	26
7	0.013	26–27	0.00294	26–27	0.70	24–25	6.2	24–25
8	0.042	14	0.00362	19–20	0.82	19–20	7.2	19–20
9	0.017	23	0.00333	22	0.75	22	6.6	22
10	0.025	17–18	0.00392	10–11	0.84	16–18	7.4	16–18
11	0.013	26–27	0.00294	26–27	0.64	27	5.6	27
12	0.035	15	0.00372	16–18	0.89	9–11	7.8	9–11
13	0.048	3–5	0.00421	4	0.95	4	8.4	4
14	0.023	21–22	0.00313	23–25	0.73	23	6.4	23
15	0.024	19–20	0.00313	23–25	0.70	24–25	6.2	24–25
16	0.024	11–20	0.00392	10–11	0.84	16–18	7.4	16–18
17	0.047	6–8	0.00401	5–9	0.93	5–8	8.2	5–8
18	0.010	30	0.00254	30–31	0.57	31	5.0	31
19	0.047	6–8	0.00401	5–9	0.93	5–8	8.2	5–8
20	0.031	15	0.00372	16–18	0.86	12–15	7.6	12–15
21	0.047	6–8	0.00401	5–9	0.93	5–8	8.2	5–8
22	0.044	11–12	0.00372	16–18	0.86	12–15	7.6	12–15
23	0.048	3–5	0.00401	5–9	0.93	5–8	8.2	5–8
24	0.006	32	0.00206	32	0.43	32	3.8	32
25	0.046	9–10	0.00382	12–15	0.89	9–11	7.8	9–11
26	0.044	11–12	0.00362	19–20	0.84	16–18	7.4	16–18
27	0.025	17–18	0.00352	21	0.80	21	7.0	21
28	0.011	28–29	0.00284	28–29	0.59	29–30	5.2	29–30
29	0.048	3–5	0.00431	1–3	1.00	1–2	8.8	1–2
30	0.051	1	0.00431	1–3	1.00	1–2	8.8	1–2
31	0.027	16	0.00382	12–15	0.82	19–20	7.2	19–20
32	0.016	24	0.00254	30–31	0.59	29–30	5.2	29–30

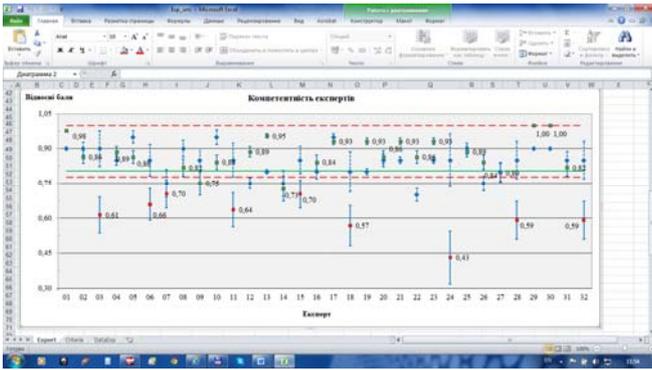


Fig. 8. Results window of Microsoft Excel 2010.

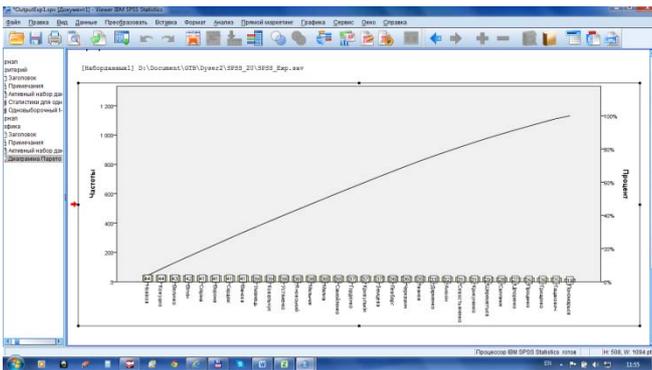


Fig. 9. Results window of IBM SPSS Statistics 20.

On the basis of all present results it is possible to talk about a rejection on the whole 12 experts (even one of the software declined). Percent of the declined experts on results an evaluation folds from 22 (7 experts are from 32) to 34 (11 experts are from 32) the concrete software. On the whole it is possible to establish the high coincidence of results of estimation: 6 from 11 (55 % – “Competence AHP 1.1”); 6 from 9 (67 % – Microsoft Excel 2010); 6 from 7 (86 % – “Competence UD 1.0” and IBM SPSS Statistics 20).

With used software Microsoft Excel 2010 was the appraised correlation of average grades for criteria (K1, ..., K5) that were used for the expert’s competence evaluation (Fig. 10) [8]. The got results show small variation of average grades for these criteria (from 6.3 to 7.7) that testifies to its quite good consistency.

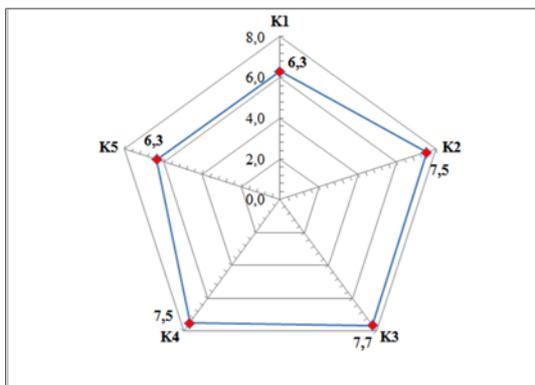


Fig. 10. Average grades for criteria.

5. CONCLUSIONS

The different methodologies of competence evaluation of experts are considered. It is important to set the finite set of necessary criteria for the quantitative evaluation of competence for certain expert with possibility of their further ranging. It will allow to define the level of competence of every expert and reasonably to do a choice most competent them in field of metrology and instrumentations. The results of quantitative estimation of competence of the experts got by means of software tools are considered, including both special, based on different methodologies of estimation and universal statistical. The comparative analysis of such quantitative evaluation is conducted that showed possibility of selection of the most competent experts. An analysis showed the high degree of coincidence of results that allow declining less competent experts also.

REFERENCES

- [1] T. B. Gordiyenko, O. M. Velychko and L. V. Kolomiets. Choice of experts for the methods of evaluation in technical regulation. *Metallurgical and Mining Industry*. 2014, No. 2 (287), pp. 90-92 (in Ukrainian).
- [2] S. Echverria-Villagomez, M. Flores-Campos, R. Pantoja-Lesso, N. Rodriguez-Damian and B. Valganon-Argueta. Human Resource and Knowledge Management System for Competences in Metrology using Information Technologies. “Future development of IMEKO concerning non-governmental cooperation in measurement and instrumentation”, *XVIII IMEKO World Congress*, Rio de Janeiro, Brazil, Sept. 2006, pp. 1-5.
- [3] T. L. Saaty and K. P. Kearns. *Analytical Planning: The Organization of Systems*, Pergamon, 1985.
- [4] T. B. Gordiyenko and O. M. Velychko. Methodology of evaluation of competence of experts with the use of Analytic Hierarchy Process. *Metallurgical and Mining Industry*. 2014, No. 2 (287), pp. 86-89 (in Ukrainian).
- [5] O. M. Velychko, S. R. Karpenko, T. B. Gordiyenko, and L. V. Kolomiets Special software tools for evaluation of competence of the experts. *Metallurgical and Mining Industry*. 2014, No. 6 (291), pp. 120-124 (in Ukrainian).
- [6] O. M. Velychko, T. B. Gordiyenko, and L. V. Kolomiets. Methodology of evaluation of competence of experts with using data uncertainties. *Metallurgical and Mining Industry*. 2014, No. 3 (288), pp. 135-137 (in Ukrainian).
- [7] O. M. Velychko, T. B. Gordiyenko, and L. V. Kolomiets. Methodologies of expert’s competence evaluation and group expert evaluation. *Metallurgical and Mining Industry*. 2015, No. 2, pp. 262-271.
- [8] O. Velychko, T. Gordiyenko. The estimation of the measurement results with using statistical methods // *Journal of Physics: Conf. Series*. IOP Publication. 2015, vol. 588, 012017, 6 p.