

Methodologies of expert's competence evaluation and group expert evaluation

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Abstract

Methodology of evaluation of expert's competence in mind of data uncertainties and results of its using in the field of standardization for forming of expert's group are considered. For the quantitative evaluation of expert's competence the special criteria with its numerical score are offered. Methodology of group expert evaluation in mind of expert's competence and results of its using in the field of standardization are considered. For the quantitative evaluation of the most essential problem questions for more detailed its consideration questions for the special questionnaire with its numerical score are worked. Key words: EXPERT, COMPETENCE, EVALUATION, METHODOLOGY, SOFTWARE

A group expert evaluation is widely used in the various spheres of activity with the aim of receipt of decisions in relation to overcoming of certain problem on the basis of opinion of skilled experts that have the special skills or knowledge in the concrete sphere of activity [1–3]. For the realization of reliable evaluation it is necessary to go near a selection expert's groups correctly that attract for realization of expert evaluation. Taking into account practical competence each of the attracted experts, their objective professional data will allow promoting exactness of expert evaluation [4–6].

The evaluation of expert's competence in the various spheres of activity with the aim of receipt of independent information on the expert competence are conducted. The reliable evaluations of expert's competence can be got with using of the specially worked out methodologies of evaluation of expert's competence, which is built on the use of different algorithms of processing of objective data about experts [7, 8]. Such methodologies are easily automatized with using of universal software that considerably simplifies the selection of skilled experts for realization concrete expert evaluation.

For a group expert evaluation it is possible to attract all known experts, it is however necessary to take into account their competence. This competence must be preliminary appraised that will allow to correct results obtained of the group expert evaluation for the increase of its authenticity and exactness. Thus may be also in general to decline the evaluation of less skilled experts.

The objective approach near the selection of experts mainly is based on documentary variant that envisages the evaluation of expert's competence on the basis of certain professional data: scientific degree, title, position, experience of work on speciality and in the sphere of the activity related to the research, amount of the published works and references to its in scientific publication, participating in the specialized councils, commissions, symposiums.

In ideal case the present are given about experts will be the average of points on all criteria of competence evaluation. In another cases such data can be the exhaustive list of sum of points on all criteria of competence evaluation. In any case a certain data uncertainties will be about experts. The range of uncertainties in these data can be

limited by the use of independent methods or special background check on its consistency.

In [8] the offered methodology of evaluation of expert's competence takes into account descriptions of data uncertainties, which belong to the sphere of comparative evaluation of level of expert's competence in various fields of activities. For realization of the offered methodology corresponding criteria are set for the numerical score of expert's competence of certain field.

In this methodology special algorithm of calculation of row of mathematical indexes is used for every expert, and also supporting value of evaluation and general standard uncertainties. The result of its realization is a quantitative evaluation of expert's competence by means of establishment of necessary level of competence taking into account the data uncertainties. For the eventual forming of expert's group, except a criterion χ^2 , the principle of Pareto can be also used.

The algorithm of evaluation of expert's competence on this methodology is presented in the Fig. 1. This algorithm is easy to realize with the use of widespread packages of mathematical software (for example, Microsoft Excel 2010 and IBM SPSS Statistics 20).

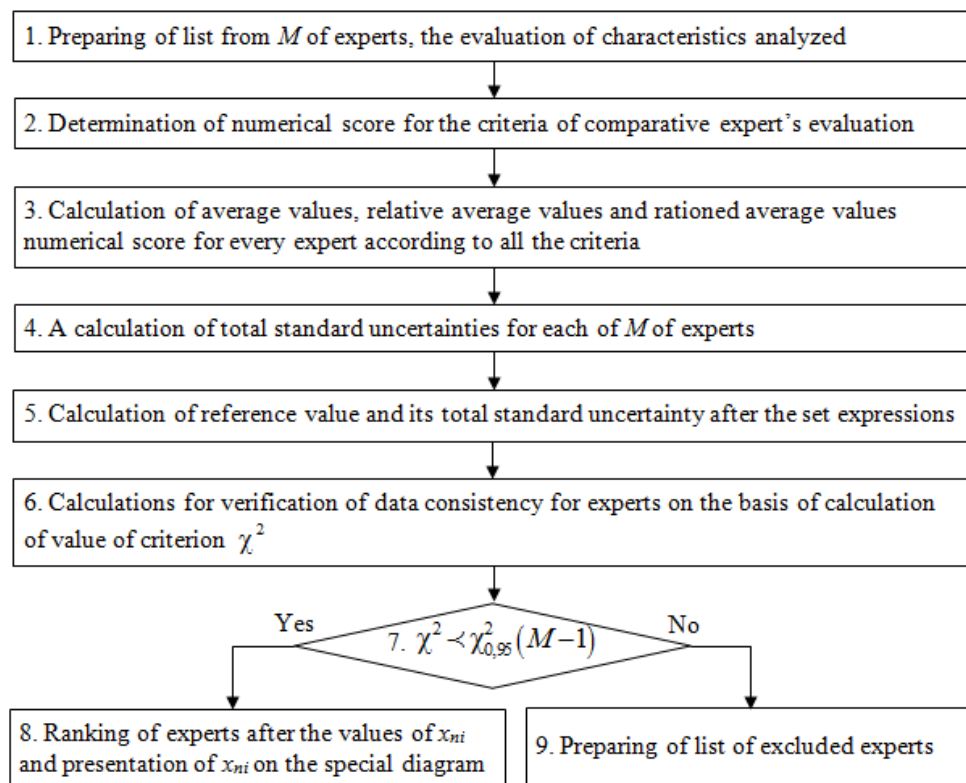


Figure 1. Algorithm of evaluation of expert's competence

For realization of the offered methodology of calculation [8]:

average values \bar{x}_i for each of M of experts for all the criteria

$$\bar{x}_i = \sum_{i=1}^M x_i / M ; \quad (1)$$

relative average values \bar{x}_{ri} for each of M of experts

$$\bar{x}_{ri} = \bar{x}_i / \sum_{i=1}^M \bar{x}_i ; \quad (2)$$

rationed average values \bar{x}_{ni} for each of M of experts

$$\bar{x}_{ni} = \bar{x}_{ri} / \bar{x}_{i\max} ; \quad (3)$$

total standard uncertainties for each of M of experts

$$u_{ci} = (1 - \bar{x}_{ni}) / 10. \quad (4)$$

Calculation of reference value x_{ref} and it

total standard uncertainty u_{ref} for total evaluation of expert's competence to make on formulas:

$$x_{ref} = \sum_{i=1}^M \frac{x_{ni}}{u_{ci}^2} / \sum_{i=1}^M \frac{1}{u_{ci}^2}, \quad u_{ref} = \sqrt{1 / \sum_{i=1}^M \frac{1}{u_{ci}^2}}. \quad (5)$$

Calculations for verification of data consistency for experts on the basis of calculation of value of criterion χ^2

$$\chi^2 = \sum_{i=1}^M \frac{(x_{ni} - x_{ref})^2}{u_{ci}^2}. \quad (6)$$

If the value of χ^2 -criterion, calculagroup expert evaluation of ways of increase of activity efficiency of national technical committees (TC) for standardization on the specially worked out criteria the evaluation of competence was also conducted for 32 attracted experts on questions of standardization. Quantitative descriptions of competence of these experts were appraised by means of universal statistical software (Microsoft Excel 2010 and IBM SPSS Statistics 20). All evaluation were done on the same criteria: K1 – education; K2 – total work experience; K3 – experience in field of standardization; K4 – experience of expert work in field of standardization; K5 – work status.

Windows of the marked universal software with final evaluation results are shown in Fig. 2 and 3.

On the basis of all present results it is possible to talk about a rejection on the whole 11 experts (declined even by one of the program). Percent of the declined experts on evaluation results folds these programs: 22 % (7 experts out of 32 for software IBM SPSS Statistics 20) and 34 % (11 experts out of 32 for software Microsoft Excel 2010). On the whole it is possible to establish the high consistency of evaluation results.

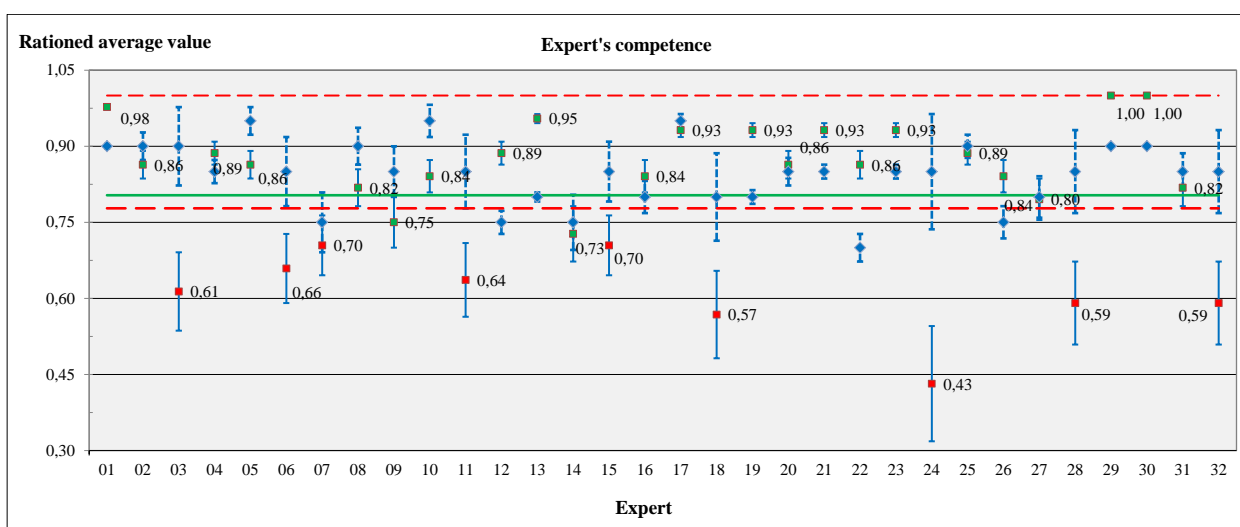


Figure 2. Appraised expert's competence with the use of the software Microsoft Excel 2010

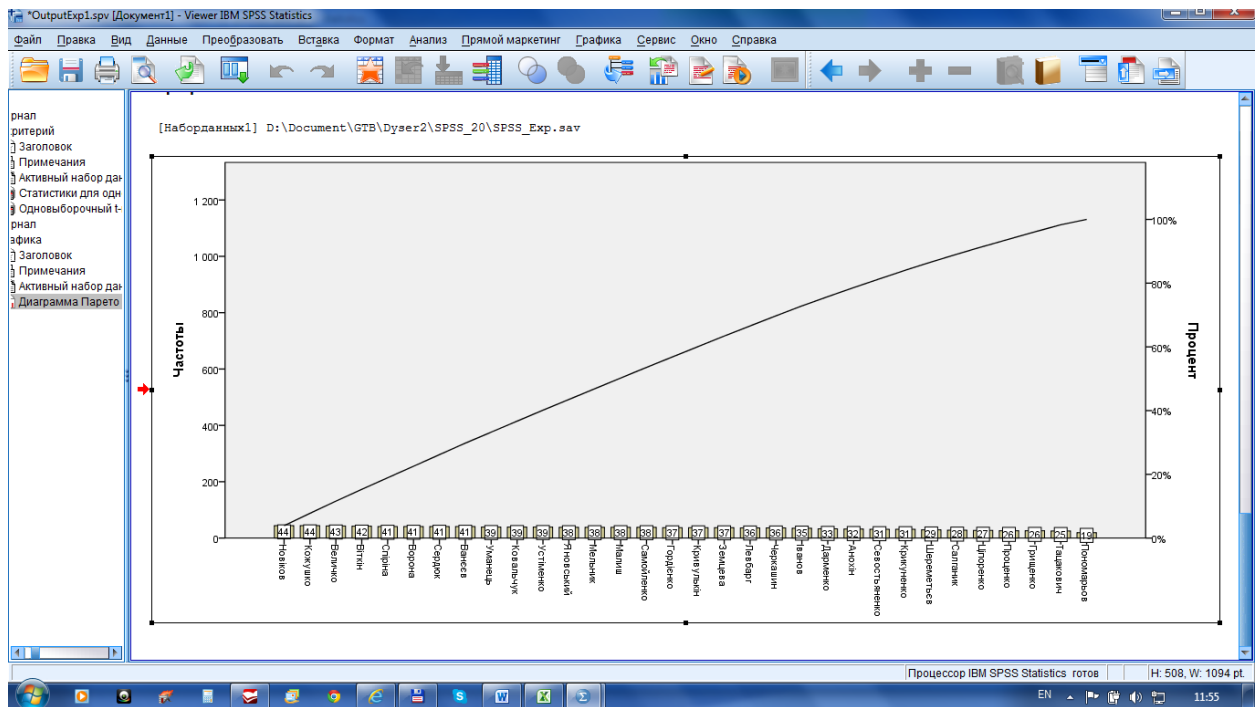


Figure 3. Appraised expert's competence with the use of the software IBM SPSS Statistics 20

With used software Microsoft Excel 2010 it was the appraised correlation of average values for criteria that were used for the expert's competence evaluation (Fig. 4). The results obtained show small variation of average values for these criteria (from 6.3 to 7.7) that testifies to its quite good consistency.

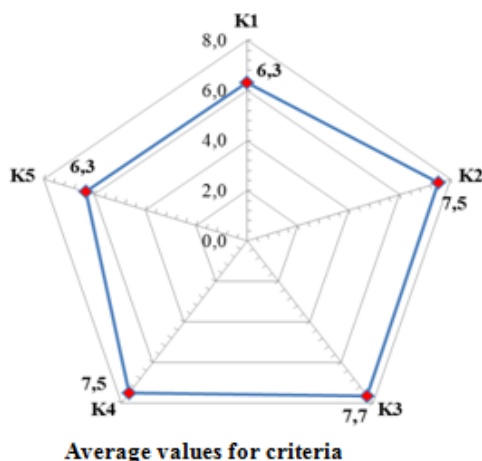


Figure 4. Average values for criteria of expert's competence evaluation

During realization of group evaluation there was also suggested to carry out self-evaluation of the competence. According to the results (Fig. 5) self-evaluation the competence on equalization with the got objective evaluation of 18 experts out of 32 (56 %) and such divergence folds (0.01 to 0.42 relative average values). It is interesting that all 12 declined experts on results an objective evaluation overestimated their competence. From 10 the most competent experts on results an objective evaluation 8 experts (80 %) underestimated the competence, and 2 other experts – self-evaluation accordingly only on 0.01 and 0.04 relative average values (accordingly on 1 % and 4 %).

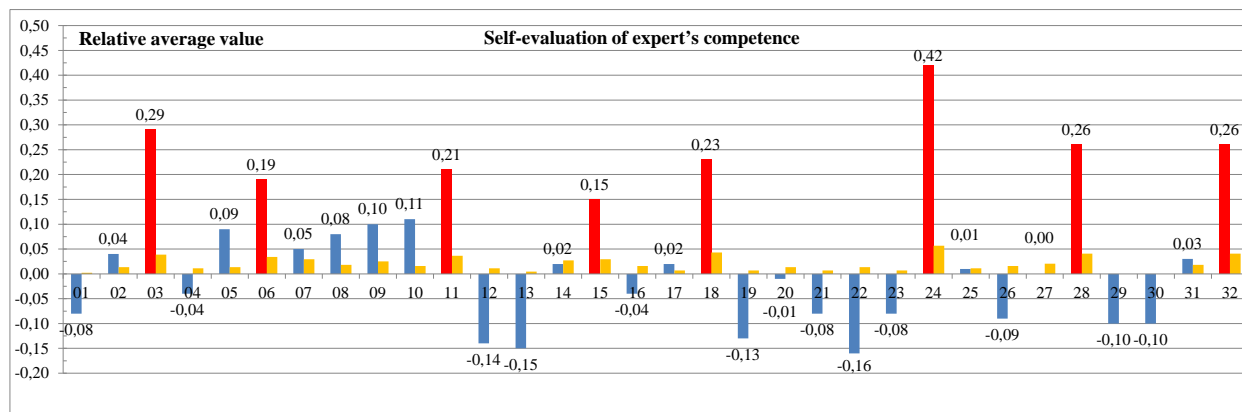


Figure 5. Self-evaluation of expert's competence

The values of the evaluation results of expert's competence in the rationed average values (in a range from 0 – minimum to 1 – maximal) for all 32 experts are given in the Table 1.

In framework of the carry out questionnaire, questioning took place also in relation to work experience in field of standardization, necessity for an achievement level

of expert. Mostly there was the answer – 5 years (15 experts, 47 %), following by the amount of the answers – 10 years (7 experts, 22 %), and the others – 6 % (for 2 experts). The results allowed specifying some quantitative evaluation on the criterion of “K4 – experience of expert in field of standardization”.

Table 1

Expert	01	02	03	04	05	06	07	08
Relative average value	0.98	0.86	0.61	0.89	0.86	0.66	0.70	0.82
Expert	09	10	11	12	13	14	15	16
Relative average value	0.75	0.84	0.64	0.89	0.95	0.73	0.70	0.84
Expert	17	18	19	20	21	22	23	24
Relative average value	0.93	0.57	0.93	0.86	0.93	0.86	0.93	0.43
Expert	25	26	27	28	29	30	31	32
Relative average value	0.89	0.84	0.80	0.59	1.00	1.00	0.82	0.59

In [9] the offered methodology of group expert evaluation takes into account the expert's competence. For realization of this methodology in field of standardization the special polling questionnaire was worked out with a list from N questions ($N = 17$), which are necessary to be analyzed. The special numerical scale was set also for realization of possibility of processing of the obtained data (for example, from 1 to 9, yes or no). The algorithm of group expert evaluation taking into account the expert's competence is shown in Fig. 6. This algorithm is possible to realize also

with the use of widespread mathematical software (for example, Microsoft Excel 2010 and IBM SPSS Statistics 20).

For realization of the offered methodology calculation:

average values \bar{x}_i for each of N questions with in mind competence coefficient k_{cj} (rationed average value) for each of M experts, who took part in evaluation (Table 1)

$$\bar{x}_i = \sum_{j=1}^M x_j \cdot k_{c_j} / M \quad (i = 1, 2, \dots, N); \quad (8)$$

reference value of expert evaluation x_{ref} for each of N questions as simple average value for all estimated questions (in numerical score)

$$x_{ref} = \sum_{i=1}^N \bar{x}_i / N; \quad (9)$$

deviation of the appraised average value \bar{x}_i from a reference value x_{ref} for each of certain questions (in numerical score)

$$D_i = \bar{x}_i - x_{ref}. \quad (10)$$

Results ranking in the order of reduction D_i and to make verification of exceeding of the got values D_i of 10 % from maximal value got values D_i for all certain questions.

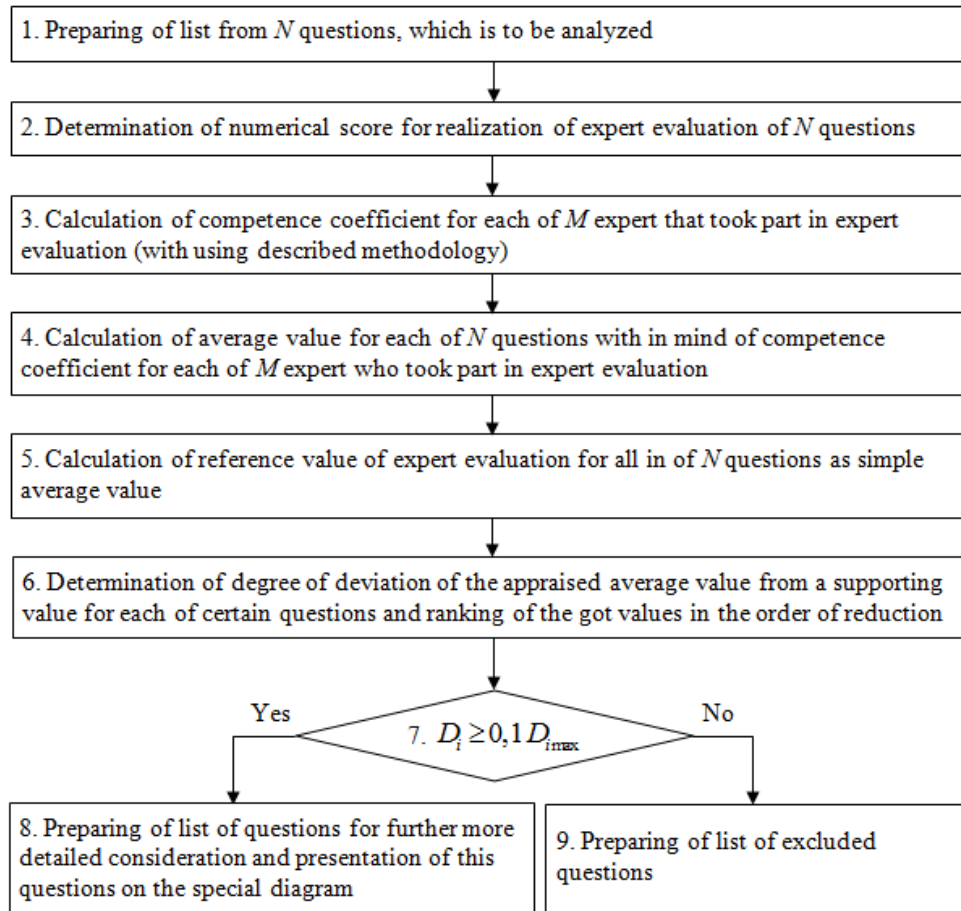


Figure 6. Algorithm of group expert's evaluation

The finishing stage is forming of list of questions for further more detailed consideration and list of the declined questions for further consideration and presentation of results on the special diagram (petalous diagram or histogram) with causing of reference value of expert evaluation.

Type of windows of universal software with final results of group expert evaluation without and with taking into account the expert's competence with application of the considered methodology shown in Fig. 7–12. An estimation

carry out for 17 problem questions (X1–X17) that contain 56 sub-questions, taking into account the set numerical score.

In Fig. 8, 9, 11 and 12 the reference values of expert estimations are inflicted as a stroke line. In Fig. 11 average values of expert estimations without taking into account expert's competence and supporting value always more corresponding values taking into account the expert's competence, so as a coefficient of competence of expert is in a range from 0 to 1.

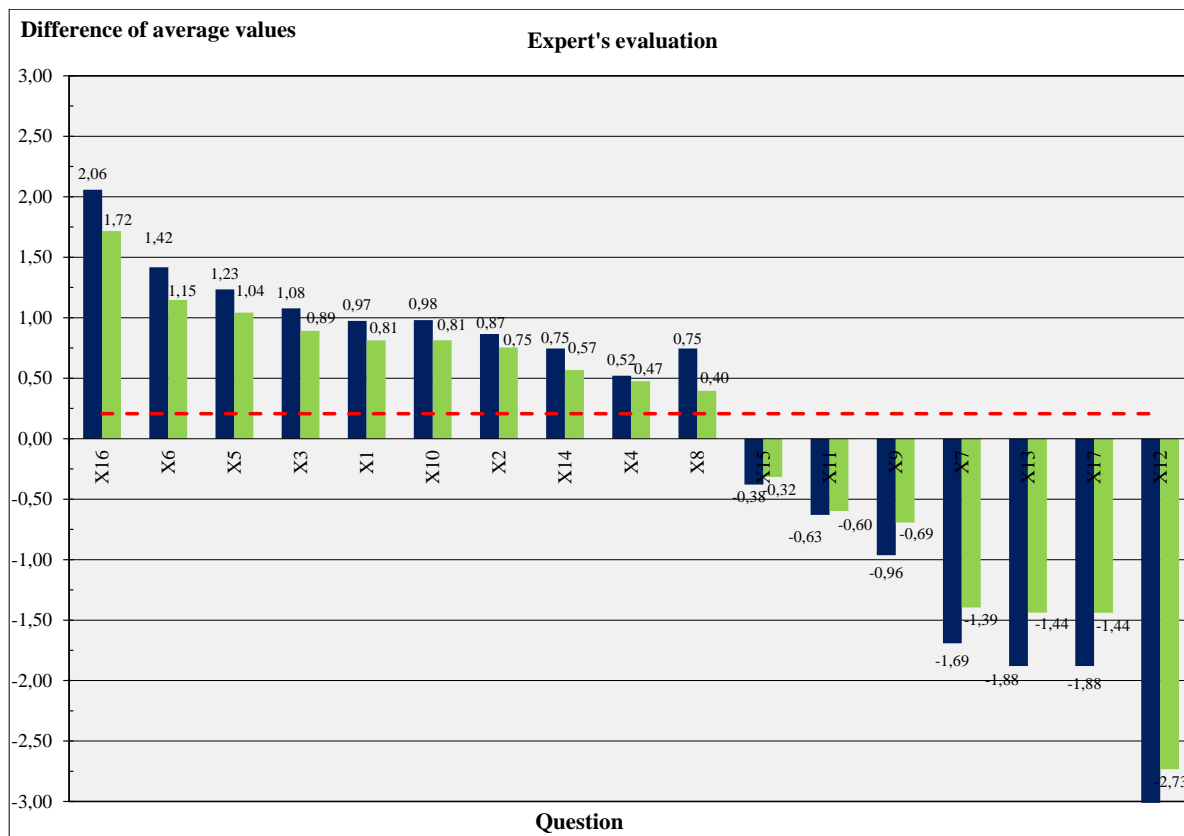


Figure 7. Histogram for the degrees of deviation of the appraised average values from a reference value for questions without and with competence of experts

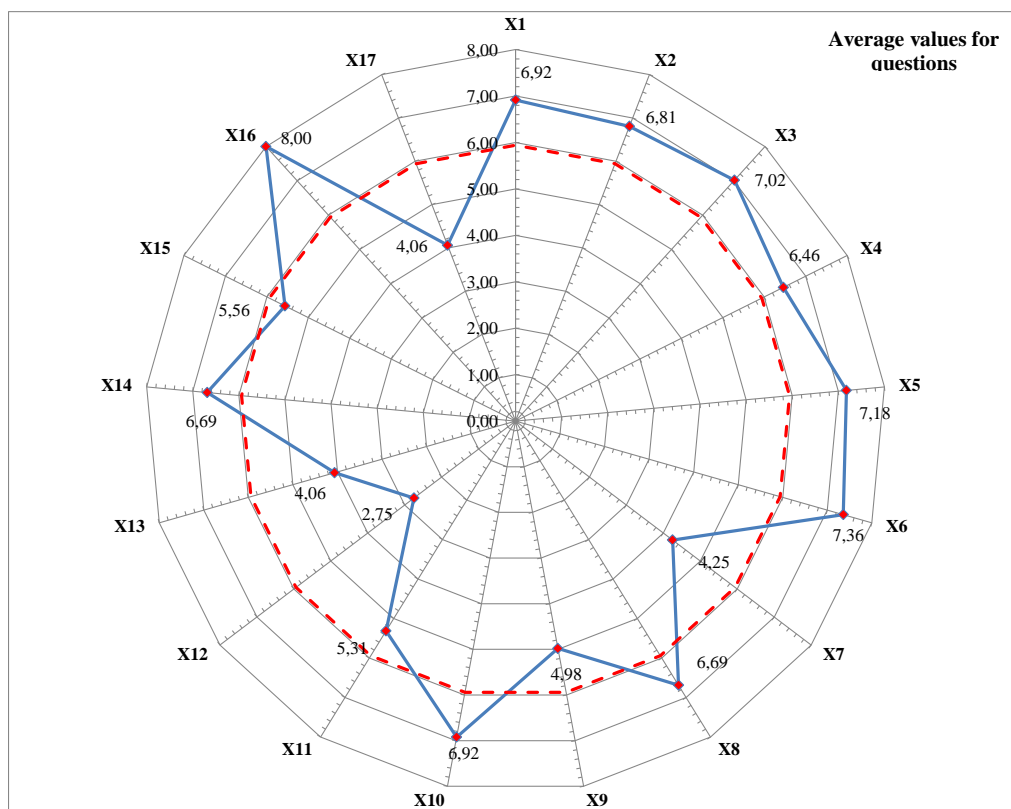


Figure 8. Petalous diagram for the average values of expert estimations for questions without the account of competence of experts

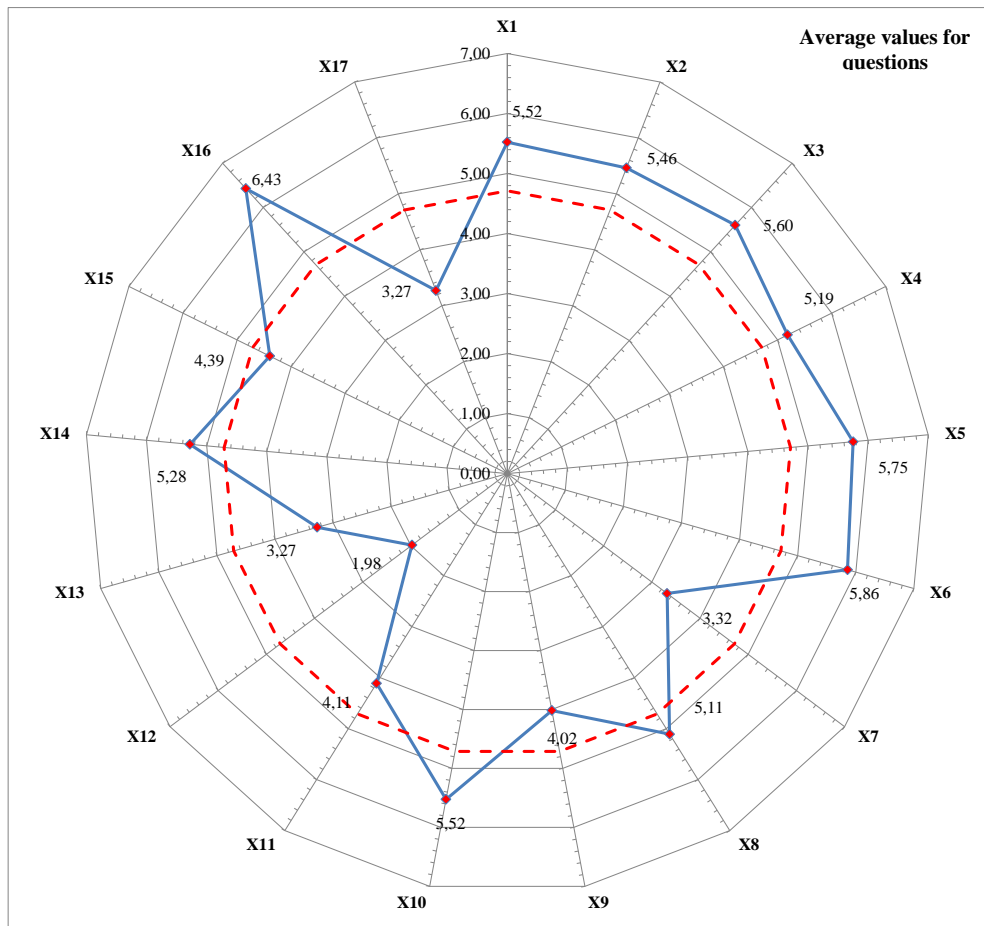


Figure 9. Petalous diagram for the average values of expert estimations for questions with the account of expert's competence

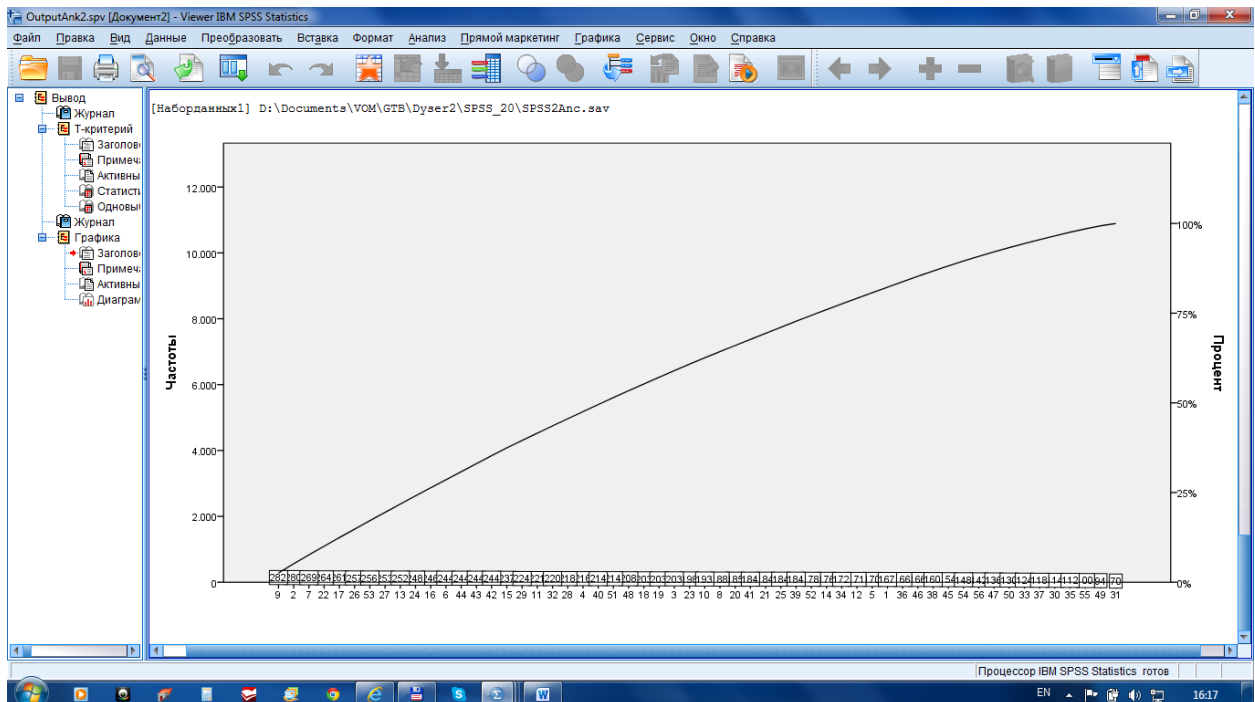


Figure 10. Appraised average values for sub-questions with the use of the IBM SPSS Statistics 20 without the account of expert's competence

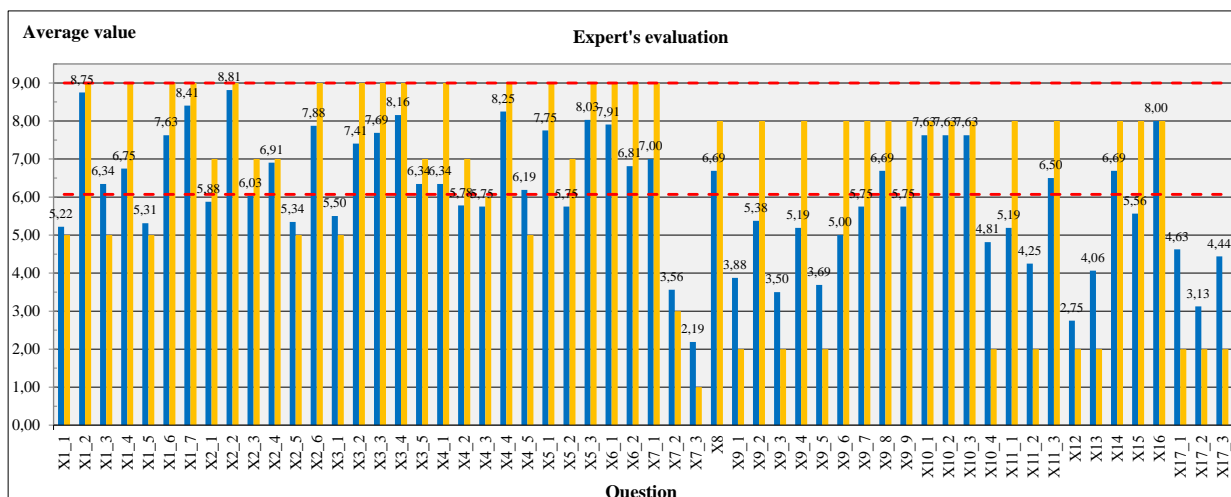


Figure 11. Appraised average values for sub-questions with the use of the Microsoft Excel 2010 without the account of expert's competence

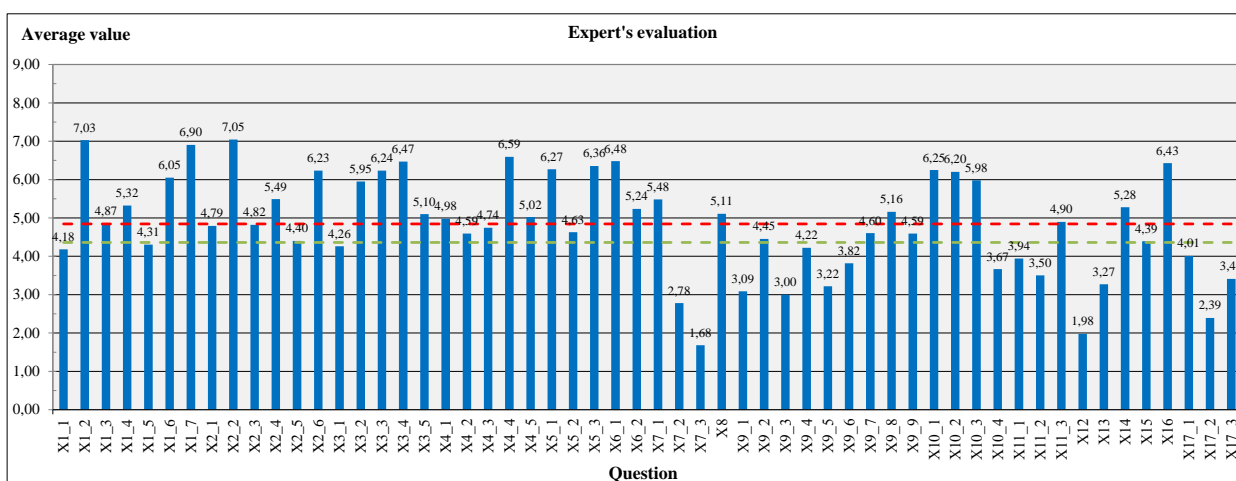


Figure 12. Appraised average values for sub-questions with the use of the Microsoft Excel 2010 with the account of expert's competence

In Fig. 8, 9, 11 and 12 the reference values of expert estimations are inflicted as a stroke line. In Fig. 11 average values of expert estimations without taking into account competence of experts and reference value always more corresponding average values taking into account the competence of experts, so as a competence coefficients of expert are in a range from 0 to 1.

Analysis of the results shown in Fig. 7–9, shows that in all cases 10 certain for consideration questions are priority for the further detailed analysis with the aim of acceptance of necessary decisions, and 7 questions – does not have near-term or in general no value for their further analysis. Major for consideration of questions are: X16 (average value with taking into account the expert's competence – 6.43); X6 (5.86); X5 (5.75); X3 (5.60); X1 and X10 (each 5.52); X2 (5.46);

X14 (5.28); X4 (5.19); X8 (5.11), and the least more important: X12 (1.98); X7 (3.32); X13 and X17 (each 3.22); X9 (4.02); X11 (4.11); X15 (4.39). The sequence of 3 questions (X14, X4, X8 – 18 % out of them general amount) differs with taking into account and not taking into account expert's competence.

In Fig. 12 the second column (more light) for each of sub-questions represents a fashion for this question, and overhead stroke line – average mode for all sub-questions. Reference values for the appraised average values with the use of Microsoft Excel 2010 without the account of expert's competence folds is 6.07, and from taking into account of expert's competence is 4.84.

Analysis of the results shown in Fig. 10 and got with application of the Pareto chart with the Lorenz curve, shows that 37 (66 %) certain for

consideration sub-questions are priority for the further detailed analysis with the aim of acceptance of necessary decisions, and 19 sub-questions (34 %) does not have near-term or in general no value for their further analysis. Average values and results of all points were estimated for each of questions. For processing of data the competence coefficients of experts were not used.

Analysis of the results shown in Fig. 11 and 12 shows that in all cases 38 sub-questions (68 %) are priority for the further detailed analysis with the aim of acceptance of necessary decisions, and 18 sub-questions (32 %) does not have near-term or in general no value for their further analysis. In this case, account of the competence coefficients of experts in any way did not influence on final evaluation having regard to the homogeneous enough evaluation of experts for questions that was examined. At the same time, taking into account 10 % of uncertainty of reference value (lower stroke line in Fig. 12) for consideration to 28 most ponderable for consideration sub-questions were added 10 ponderable sub-questions.

Methodology of evaluation of expert's competence taking into account data uncertainty is expedient to apply as an useful instrument for the comparative estimation of expert's competence on the basis of their objective data on the set criteria for the different fields of activity. This allows 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 activity and to decline experts, objective data, which does not confirm the certain level of set criteria.

The increase of accuracy of group expert evaluation and considerable reduction of time on it realization is assisted by the special methodologies of expert evaluation taking into account the expert's competence, which participate in this evaluation. Realization of such methodologies by means of universal statistical software allows to carry out the selection of the most priority questions in certain fields of activity from those that is certain for consideration an expert group, and also rejections of questions, which does not

have near-term or in general no value for a further analysis.

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