

E.U. Pokuda, V.I. Korsun

**METHOD OF ASSESSING COMPETENCE OF EXPERTS
DIAGNOSING BASIC BLOCKS OF QUARRY
DUMPTRUCKS**

Abstract. Methodology of testing consistency of the data obtained during the assessment of expert competence is considered. Criteria of assessing the experts' competence with weighing coefficients are analyzed. Data consistency is assessed with the criterion. Based on the offered algorithm, a program in VBA programming language is designed. The offered methodology is demonstrated on the specific example of forming a group of experts to diagnose the basic blocks of quarry dumptrucks.

Keywords: expert, competence assessment, consistency, criterion.

Introduction

At present, expert's opinion is often used to solve problems in different spheres of human activities. Expert assessment is the procedure of assessing a problem based on the experts' opinion (specialists in a certain field) aimed at further decision-making (for instance, to increase the performance at an enterprise). For participation in such assessment, highly qualified specialists with domain-specific knowledge and skills are engaged. However, selection of experts seems to be problematic. To form such group of experts it is necessary to assess the experts' competence.

Analysis of recent achievements

In papers [2, 4, 5, 7], generic methodology of assessing the level of experts' competence is considered. Most commonly, the selection of experts is based on the objective approach. The studied selection of experts supposes the selection of highly qualified specialists based on certain professional data. Earlier in the work [1], generic methodology of selecting expert group members taking into account the competence level of each expert.

Problem statement

While forming an expert group, some uncertainty of the obtained data is inevitable. To reduce the uncertainty, it is offered to use the data consistency test. The offered method will be considered on the specific example of forming an expert group to assess the basic blocks of quarry dumptrucks.

Main part

In paper [3], multi-stage process of forming an expert group is discussed. In Table 1 are presented criteria of assessing experts' competence by weighing criteria [1].

Table 1

Criteria of assessing experts' competence

Criteria		Criterion alternative
1	Field of expertise	Automobile diagnosis – 1; automobiles and automobile transport – 0.9; transport management – 0.8; machine building – 0.7; other – 0.5.
2	Academic degree	Doctor of Technical Sciences – 1; Candidate of Technical Sciences – 0.8; Master – 0.6; Specialist – 0.5; Bachelor – 0.4.
3	Position	Professor – 1; Assistant Professor – 0.8; Lecturer – 0.6; Engineer – 0.8; Research Worker – 0.8.
4	Record of work	Less than 5 years – 0.5; from 5 to 10 years – 0.6; from 10 to 15 years – 0.7; from 15 to 20 years – 0.8; from 20 to 30 years – 0.9; more than 30 years – 1.
5	Knowledge and skills	Altogether 10 specific skills and areas of knowledge 0.1 points each are supposed.
6	The source of justifying the expert's opinion	The following criteria are included in this category: conducted theoretical analysis; production experience; synthesis of printed papers (both domestic and foreign); intuition. Each criterion has 3 options: high – 1; medium – 0.6; low – 0.3.
7	Personal characteristics	Altogether 10 characteristics are supposed, each is valued as follows: always – 1; almost always – 0.9; very often – 0.8; often – 0.7; more than average – 0.6; average – 0.5; less than average – 0.4; rarely – 0.3; hardly ever – 0.2; sometimes – 0.1, never – 0.
8	Experience of working as an expert	If the experience of working as an expert is less than 5 times, than divide the number by 5, if it is more than 5 – 1.
9	Domestic publications	Less than 5 – 0.5; from 5 to 10 – 0.6; from 10 to 15 – 0.7; from 15 to 20 – 0.8; from 20 to 30 – 0.9; more than 30 – 1.
10	Foreign publications	Less than 5 – 0.6; or from 5 to 10 – 0.7; from 10 to 15 – 0.8; from 15 to 20 – 0.9; more than 20 – 1.
11	Patents	If the number of patents is less than 5, than divide the number by 5, if it is more than 5 – 1.
12	Introductions	If the number of introductions is less than 10, than divide the number by 10, if it is more than 10 – 1.
13	Participation in symposia	If the number of participations in symposia is less than 10, than divide the number by 10, if it is more than 10 – 1.

Assessment of competence of the i -th expert K_i is calculated with weighing coefficient of each criterion taken into account. To realize the offered method it is necessary to calculate the following criteria [2]:

- 1) average score \overline{K}_i for each expert in all criteria:

$$\overline{K}_i = \frac{K_i}{m}, \quad (1)$$

where m – is the total number of experts.

- 2) relative average score \overline{K}_{ri} for each of m experts:

$$\overline{K}_{ri} = \frac{\overline{K}_i}{\sum_{i=1}^m \overline{K}_i} \quad (2)$$

- 3) nominated average score \overline{K}_{ni} for each of m experts:

$$\overline{K}_{ni} = \frac{\overline{K}_{ri}}{\max_{i=1,m}(\overline{K}_i)} \quad (3)$$

- 4) general standard uncertainty of each i -th expert:

$$u_{ci} = 1 - K_i. \quad (4)$$

All data are stocked in Table 2.

Table 2

Example of drawing up the table

Expert, i	K_i	\overline{K}_i	\overline{K}_{ri}	\overline{K}_{ni}	u_{ci}
1					
2					
...
m					

It is also necessary to calculate the reference value K_{ref} and its general standard uncertainty u_{ref} for general assessment of experts:

$$K_{ref} = \frac{\sum_{i=1}^m \overline{K}_{ni}}{\sum_{i=1}^m \frac{1}{u_{ci}}}, \quad u_{ref} = \sqrt{\frac{1}{\sum_{i=1}^m \frac{1}{u_{ci}^2}}}. \quad (5)$$

To check the consistency of data, it is necessary to calculate χ^2 criterion [6]:

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

If the criterion value calculated by the i -th expert data does not exceed the critical value for the level of confidence 0.95 and the number of degrees of freedom $m - 1$ (Table 3):

$$\chi^2 < \chi_{0,95}^2(m-1), \quad (7)$$

than the data of the formed group with m experts are considered to be consistent.

Table 3

The value of χ^2 criterion for the group with m experts

$m-1$	χ^2	$m-1$	χ^2	$m-1$	χ^2	$m-1$	χ^2
3	0.71	8	3.33	13	6.57	18	10.11
4	1.15	9	3.94	14	7.26	19	10.85
5	1.64	10	4.57	15	7.97	20	11.69
6	2.17	11	5.23	16	8.67	21	12.34
7	2.73	12	5.89	17	9.39	22	13.09

If condition (7) is fulfilled, than the expert group membership is confirmed and ranked by $\overline{K_{ni}}$ criterion.

In Fig. 1 is given the algorithm of assessment of experts' competence taking into account uncertainty data.

Based on the offered algorithm, a program written in VBA programming language is developed.

Let's consider the example of the program for the assumed group of experts to assess the basic state of quarry dumptrucks.

In Table 4 is given the calculation of criteria.

Table 4

Calculation of consistency of experts' competence taking into account data uncertainty

Expert, i	K_i	$\overline{K_i}$	$\overline{K_{ri}}$	$\overline{K_{ni}}$	u_{ci}
1	0.98	0.075	0.094	0.124	0.02
2	0.93	0.072	0.089	0.118	0.07
3	0.88	0.068	0.084	0.111	0.12
4	0.87	0.067	0.083	0.11	0.13
5	0.85	0.065	0.081	0.108	0.15
6	0.84	0.065	0.08	0.106	0.16
7	0.79	0.061	0.075	0.1	0.21
8	0.77	0.059	0.073	0.097	0.23
9	0.75	0.058	0.072	0.095	0.25
10	0.73	0.056	0.07	0.092	0.27
11	0.72	0.055	0.069	0.091	0.28
12	0.7	0.054	0.067	0.089	0.3
13	0.67	0.052	0.064	0.085	0.33

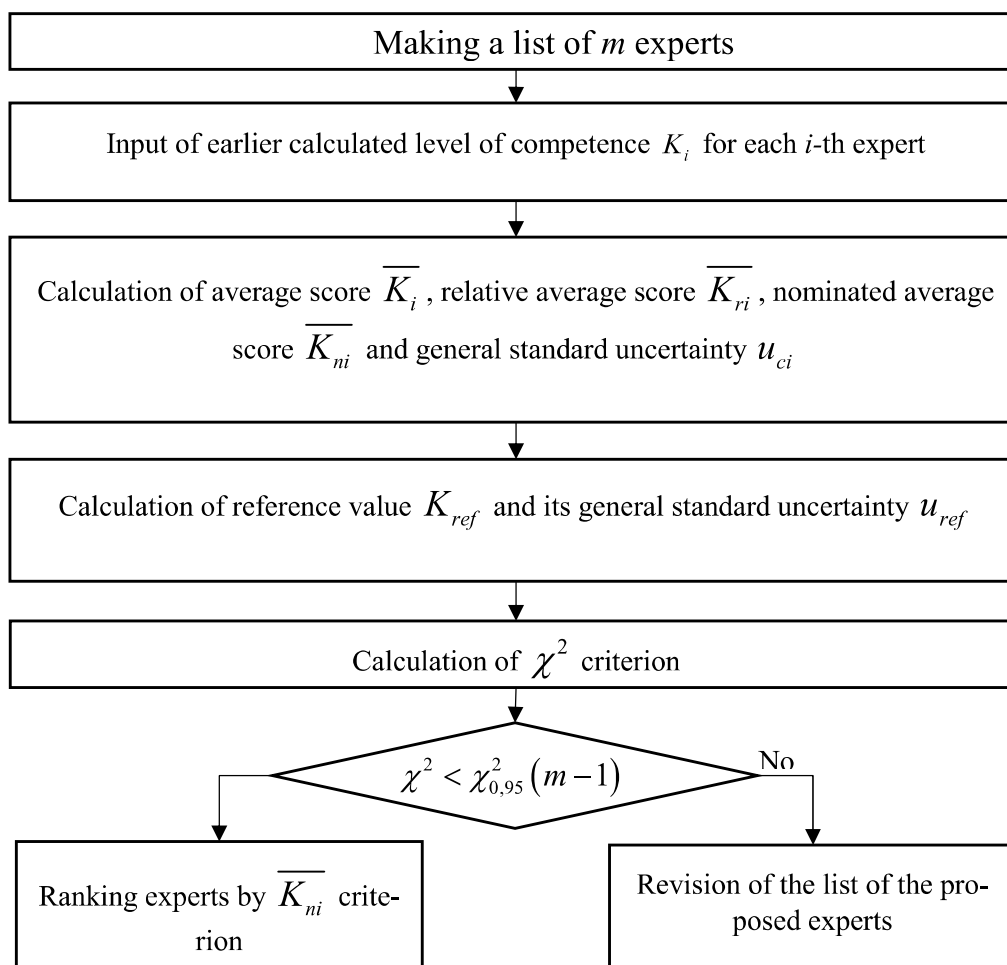


Figure 1. Algorithm of assessing the experts' competence taking into account data uncertainty

The calculation shows that: reference value is $K_{ref} = 0,122$, general standard uncertainty is $u_{ref} = 0,052$ and criterion $\chi^2 = 0,132$. Table value of the criterion $\chi^2_{0,95}(m-1)$, where, it equals $\chi^2_{0,95}(12) = 5,89$. Consequently, condition (7) is fulfilled $0,132 < 5,89$, thus the group of experts is confirmed by χ^2 criterion.

Conclusions

The considered method allows testing consistency of the data obtained during the assessment of experts' competence. The algorithm of calculation is presented, and the program in VBA programming language is realized. The offered method is considered on the specific example of forming a group of experts to assess the basic blocks of quarry dumptrucks.

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