Prospects for the development of the experts’ competence assessing tools as one of the TOPSIS method stages

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Abstract. The questions of social sectors management are currently relevant. One of the problems is the almost complete absence of any mechanism for prices and tariffs managing, as well as enterprises evaluating in such areas as housing and communal services, public transport and public health service in order to determine the optimal “producer-consumer” pair. Within the framework of the conducted studies, it was revealed that the TOPSIS method adapted by the authors is suitable for this mechanism implementation; however, at the moment, within its framework, the procedure for the experts’ competence assessing has not been implemented. The possibility of mechanism developing for this procedure implementing based on the Delphi methods, Kemeny median and hierarchy analysis is being considered. It is advisable to use the proposed method for experts assessing not only in social sectors, but also in the assessments conducting process in any areas that require the experts’ involvement with different competence levels.

1. Introduction
The availability of an effective approach to the multicriteria analysis of alternatives can be almost definitely considered as a key factor on which the quality of the assessment depends. However, it is worth considering the fact that experts of different competence levels can be involved in this process, which noticeably affects the assessment quality and its objectivity. This issue is also acute within the framework of the study, the main goal of which is the development of economic and mathematical methods and models for the management of social sectors, which is being carried out by the authors at the present time. In this regard, the development of effective methods for assessing the experts’ competence becomes urgent.

Today, one of the most common methods of expert assessment is the method of average scores; in general, in this case we are talking about a group of methods based on the scores averaging given by experts to various objects of expertise. However, these methods usage is not always correct, since the scores measurement in this case is carried out in an ordinal scale, which is not always suitable for convenient use.

The developing possibility of a multimeter method for assessing the experts competence,
based on the methods of the Kemeny, Delphi median and the hierarchies analysis is analized in the article.

2. Materials and methods

As it was noted earlier, the average scores (ranks) method application is not always correct. In this regard, it is often proposed to use the medians as the average scores (or their combination with the arithmetic average of the scores).

The essence of the average arithmetic ranks method is simple: the ranks sum of the alternatives is calculated and divided by the number of experts; the lower the obtained average rank, the better (in our case, more competent) the alternative (expert).

The method of rank medians is based on the relevance to rank all expert assessments in ascending order and to calculate further the median. By calculating results combining of the average arithmetic ranks and the medians ranks (comparing them), it is possible to rank experts according to their competence level.

The described assessment methods application shows itself well precisely when it is necessary to carry out the procedure of averaging expert assessments; however, in our case, even a methods combination does not give the desired result, since a large share of subjectivity remains in the expert assessment of the competence level of involved at the first stage by other persons specialists.

Another method of searching for "group expert assessment" is the construction of a generalized expert assessment using the Kemeny median. This is the optimization method and it is based on minimizing the distance (metric) between binary ratios:

\[ d(A, B) = \sum |a_{ij} - b_{ij}|. \]  

Kemeny's median is the average expert opinion; the law of large numbers is valid for the method, which in the case of this method results in obtaining a "true opinion" of experts with an increase in their number.

However, this method, used in its pure form, can still be considered quite subjective.

Based on the practices that have proven themselves in the expert assessment of various objects and phenomena, the authors consider it possible to use the Kemeny method in conjunction with the Delphi method. In this case, the Delphi method is used for the initial ranking of factors and the Kemeny method is used to analyze the expert opinions convergence at the time of completion of each new iteration of the expert judgment.

It should be noted that the Delphi method in this case is used not within the framework of forecasting, for the goals achievement it is not entirely effective, but for a simple ranking of criteria and / or alternatives, which is its direct purpose. Kemeny's method in this case can be used as a tool for implementing of the Delphi method analytical stage: checking the consistency of expert opinions.

An adapted method for hierarchy analyzing can also be used to assess the competence of experts. This method application in its pure form allows pairwise comparison of the entire set of alternatives, as well as the criteria by which they are evaluated. The hierarchy analysis method provides a weighted estimate of each alternative for which linguistic variables are used. This makes it possible to simplify greatly the work of the decision-maker, while at the same time objectifying it to a proper extent.

The first stage result of the standard method for hierarchy analyzing is a set of matrices, which present the results of pairwise criteria comparisons used in the assessment, as well as alternatives for compliance with each criterion. Normalization of the obtained
matrices, as well as the calculation of the alternatives weights (initially for each criterion separately, and then as a whole), make it possible to identify the optimal alternative.

The experts competence assessing method, which development possibility is considered in this article, is supposed to be used as one of the stages of a multifacet methodology for enterprises assessing for the selection of the optimal pair "producer-consumer" in social spheres: housing and communal services, public transport and medicine. The proposed by the authors method is based on the TOPSIS method and includes the following steps:

1) the criteria groups formation for enterprises assessing in a specific social sector (can be carried out once and then revised as necessary);
2) assigning weights to particular criteria and criteria groups (for each assessment, taking into account the requirements of a specific consumers group);
3) elimination of the criteria structuredness (for example, using elements of the hierarchy analysis method);
4) assessment of the experts competence;
5) assessment of alternatives by a experts group (using linguistic variable to improve the accuracy and efficiency of the procedure);
6) formation of a criteria matrix:
\[ R^l = \left[ \begin{array}{c} r_{i\ell}^l \end{array} \right], l = 1, g \leftrightarrow \left[ \begin{array}{c} a_{i\ell}^l, b_{i\ell}^l, c_{i\ell}^l, d_{i\ell}^l \end{array} \right], l = 1, g \]  \hspace{1cm} (2)
7) the results conversion obtained from linguistic variables into fuzzy trapezoidal numbers;
8) recalculation of the criteria matrix, taking into account the coefficients of the experts competence:
\[ R^{vl} = \left[ \begin{array}{c} r_{i\ell}^{vl} \end{array} \right], l = 1, g \leftrightarrow \left[ \begin{array}{c} a_{i\ell}^{vl}, b_{i\ell}^{vl}, c_{i\ell}^{vl}, d_{i\ell}^{vl} \end{array} \right], l = 1, g \]  \hspace{1cm} (3)
9) the matrix aggregation:
\[ a_{i\ell} = \left\{ \min \left\{ a_{i\ell}^{vl} \right\}, l = 1, g \right\} \hspace{1cm} b_{i\ell} = \frac{1}{g} \sum_{l=1}^{g} b_{i\ell}^{vl} \hspace{1cm} c_{i\ell} = \frac{1}{g} \sum_{l=1}^{g} c_{i\ell}^{vl} \hspace{1cm} d_{i\ell} = \left\{ \max \left\{ d_{i\ell}^{vl} \right\}, l = 1, g \right\} \]  \hspace{1cm} (4)
10) formation of a weighted fuzzy matrix (by multiplying the matrix elements by the subtest weights);
11) matrix normalization:
\[ R_{i\ell}^{N} = \left[ r_{i\ell}^{N} \right] \leftrightarrow \left[ a_{i\ell}^{N}, b_{i\ell}^{N}, c_{i\ell}^{N}, d_{i\ell}^{N} \right] \leftrightarrow \left[ \frac{a_{i\ell}^{N}}{a_{i\ell}^{N}}, \frac{b_{i\ell}^{N}}{b_{i\ell}^{N}}, \frac{c_{i\ell}^{N}}{c_{i\ell}^{N}}, \frac{d_{i\ell}^{N}}{d_{i\ell}^{N}} \right] \]  \hspace{1cm} (5)
12) calculation of "ideal negative" and "ideal positive" solutions and matrixes corresponding to them:
\[ a_{i\ell}^{N} = \left\{ \min \left\{ a_{i\ell}^{N} \right\}, i = 1, n \right\} \hspace{1cm} X^- = \left[ a_{i\ell}^{-} \right]^{N} \hspace{1cm} d_{i\ell}^{N} = \left\{ \max \left\{ d_{i\ell}^{N} \right\}, i = 1, n \right\} \hspace{1cm} X^+ = \left[ d_{i\ell}^{N} \right] \]  \hspace{1cm} (6)
13) the distances calculation of each available alternative to the "ideal positive" and "ideal negative" solution:
14) the alternatives proximity coefficient calculation.

\[ D^+(x_i) = \sqrt{\sum_{j=1}^{n} (D^+(x_i, X^j))^2}; \]

\[ D^-(x_i) = \sqrt{\sum_{j=1}^{n} (D^-(x_i, X^j))^2}. \]

Obviously, the proposed by the authors method will be used at stage 4 and it should be carried out not only at the initial introduction of an expert into a group of decision-makers in a particular area, but also for periodic reassessment of his competence.

3. Results and discussion

Experts of different specializations should be mainly involved in the examination of enterprises in various social spheres. In this regard, for each assessed area, it is worth forming its own list of criteria for the experts competence assessing. However, each of them should include such evaluation criteria as the level of education, work experience in the specific work field, experience in examinations conducting in this direction.

The methods proposed by the authors are planned to be used separately: an adapted method of hierarchies analyzing for the initial assessment of the expert's competence and, if necessary, his complete reassessment; a combined method based on the Delphi method and Kemeny's median only during the re-evaluating the experts competence. Let's consider each of them.

With the adaptation, the essence of the hierarchy analysis method is not lost: to assess alternatives, a hierarchy should be built, the top of which will be the goal of the analysis, the middle level is the criteria for experts evaluating to determine their level of competence, the lower level is specific alternatives. Note that the criteria chosen for the analysis can also be assessed using the classical method of hierarchies analyzing to rank them by priority.

As an assessment base, an expert can be offered test tasks, case tasks, an interview, etc. These tasks assessment results by a decision-maker will form an assessment matrix:

\[ A = \begin{bmatrix} a_{11} & a_{12} & \ldots & a_{1n} \\ a_{21} & a_{22} & \ldots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{m1} & a_{m2} & \ldots & a_{mn} \end{bmatrix} \]

The sum of points scored by a particular expert can be calculated using the following formula:

\[ \text{Sum} x_i = \sum_{j=1}^{n} a_{ij} \]

Along with calculating the total points scored by a specific expert, you should calculate the
total points for a specific factor:

\[ SumK_{rj} = \sum_{i=1}^{m} a_{ij}, \]  

(14)

The weight of each expert on a combination of factors is determined as follows:

\[ V_i = \frac{\sum_{i=1}^{m} \sum_{j=1}^{n} a_{ij}}{\sum_{j=1}^{n} a_{ij}}, \sum_{i=1}^{m} V_i = 1. \]  

(15)

A more accurate assessment of experts can be achieved by expert's weight calculating for each assessment criterion:

\[ b_{ij} = \frac{a_{ij}}{\sum_{i=1}^{m} a_{ij}} = \frac{a_{ij}}{\sum_{i=1}^{m} \sum_{j=1}^{n} a_{ij}}. \]  

(16)

You should also calculate the weights sum of each expert for all factors:

\[ SumExp_i = \sum_{j=1}^{n} b_{ij}. \]  

(17)

Next, the expert's weight is calculated for all factors:

\[ V_i = \frac{SumExp_i}{\sum_{i=1}^{m} \sum_{j=1}^{n} b_{ij}} = \frac{\sum_{j=1}^{n} b_{ij}}{\sum_{i=1}^{m} \sum_{j=1}^{n} b_{ij}}. \]  

(18)

Based on the results obtained at the previous stage, it is already possible to rank the experts, identifying the most competent ones. However, to improve the quality of the examination, it is permissible to adjust the weights, taking into account their importance for the examination (or a specific decision-maker).

The envisaged by the authors for reassessing the experts competence combined method should be implemented by offering them for analysis previously evaluated enterprises of one of the social spheres; it is obvious that in this case the assessment of these enterprises should be recognized as objective. The members of the expert group evaluate the proposed alternatives independently; the evaluation results are then compared with the “reference” ones. Iterations can be repeated until the decision-maker obtains a result with a satisfactory degree of conformity to the "standard"; calculations in this case are carried out by the standard Kemeny' median method.

Such a combined method usage makes it possible not to assess each expert according to a number of criteria, but at the same time it is enough to assess each of them objectively and to form groups of experts whose opinions have a sufficiently high degree of agreement. It is advisable to use it to test the experts who previously participated in the ranking of alternatives that have gone through the assessment procedure using the adapted hierarchy analysis method. It is also obvious that this kind of analysis requires the availability of a sufficient number of reliable estimates obtained in previous periods and by other experts.
4. Conclusion
The methods for the experts competence assessing proposed by the authors will become an important component of the method for enterprises assessing in social spheres, providing an opportunity to obtain a more objective analysis of alternatives [1].

In general, the methods can be considered universal, since with their help, with an insignificant clarification of the criteria base, expert assessment can be made not only in the declared social spheres, but also in such industries as agriculture, consumer goods industry and capital goods industry [2, 3], etc.

The refinement of the declared methods, the formation of a basic list of evaluation criteria will allow not only to carry out the analysis of decision-makers with high accuracy, ensuring that the results of this analysis are taken into account in the inspections, but also to increase the functioning efficiency of those industries for the examination of which these persons will be involved in the future.

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