International Business Management 10 (16): 3354-3358, 2016
ISSN: 1993-5250

Selecting the Innovative Projects Taking into Account the Sensitivity of Multi Criteria Evaluation from the Changes of Expert Judgments

[2]Vadim A. Lomazov, [1]Elena V. Nesterova, [1]Valentina I. Lomazova,
[1]Valery G. Nesterov, [1]Svetlana V. Igrunova and [2]David A. Petrosov
[1]Belgorod State University, Pobedy St., 85, 308015 Belgorod, Russia
[2]Belgorod State Agricultural University, 1 ul. Vavilova, pos. Mayskiy,
Belgorod Region, 308503 Belgorod, Russia

Abstract: The research is dedicated to the development of the expert technology methodology in evaluating, choosing and the following implementation of innovative projects in the social sphere. In evaluating the projects it was proposed to consider not only social but also political, economic, technological, scientific and innovative aspects. The conversion of projects performance figures to a dimensionless form allowed the use of a multi-level hierarchical system of criteria reflecting the relative importance of the project indicators for the individual aspects. The decision support procedure was developed in this research which consists in reducing the area of selection, after which the final selection of projects is made by the decision maker. As part of the procedure it is proposed to take into account the possible changes in the values of expert judgments about the relative importance of indicators and assessment criteria. The accounting of changes in the sensitivity of the expert judgments is made on the basis of simulation computational experiment. Preliminary results of the proposed approach in the framework of a research prototype of information-analytical system of multi-criteria evaluation and selection of innovative projects in the health sector are evidence of its effectiveness.

Key words: Social project management, innovative project, multi criteria evaluation, expert technology, decision support, sensitivity

INTRODUCTION

The successful implementation of innovative projects in the spheres of education, science, culture, health and other social sectors largely determine the quality of life of individuals and society in whole. However, limited resources do not allow to implement the large number of projects of this kind simultaneously that makes it relevant to a thorough evaluation and selection of projects to be supported by charity foundations, non-governmental organizations and local authorities (PMI, 2008; Hidalgo, 2015).

The specific feature of assessment and selection of social projects is the necessity to integrate a large number of parameters (and the relationships between them), many of which are not quantitative but qualitative in nature which leads to the use of modern expert technologies, based on the theory of decision-making methods and simulation. The innovative character of social projects complicates their expertise significantly and makes it relevant scientific substantiation of the expert selection (Hidalgo, 2015; Lomazov and Nehotina, 2013a, b). It is necessary to take into account the possible changes of expert judgment on the estimated project due to both objective (changes in the scope of the project) and subjective (change on application submissions) factors (Triantaphyllou and Sanchez, 1997; Dmitriev and Lomazov, 2014).

The purpose of this study is to provide a tool support of multi-criteria expert evaluation and selection of innovative projects in the social sphere, taking into account possible changes of expert judgment.

MATERIALS AND METHODS

Information modeling and multicriteria expert evaluation of social projects: The variety of objectives which is characteristic for social projects, generates multicriteriality in their assessment. Currently, for the construction of complex projects assessment PEST-analysis is widely used (PMI, 2008) which allows to allocate Political (Pol), Economic (Econ), Social (Soc) and technological objectives (components) of the project. Let's consider as an example the innovative projects in the sphere of public health. In this case it is advisable to change the typical structure of considered purposes:

Corresponding Author: Vadim A. Lomazov, Belgorod State University, Pobedy St., 85, 308015 Belgorod, Russia

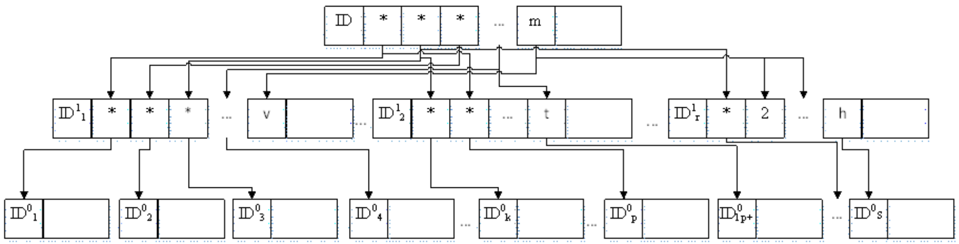

Fig. 1: The hierarchy of the criteria of innovation projects in the healthcare system

- To replace common to all projects of technological component of its specification for the region-Medical (Med) component
- To complement the composition of the considered purposes including scientific Innovation (Innov) component

In the construction of the evaluation criteria, the relevant objectives of the project, it is advisable to separate the effectiveness of the project during its implementation (Ef) and possible losses (with some probability) due to improper execution of the project (Risk). For example, according to the construction of the hierarchy of criteria (Fig. 1) criterion CritEconRisk reflects the Economic (Econ) Risk (Risk) in the implementation of the project.

The lower level of the hierarchy corresponds to parameters (indicators), the values of which are presented in the tender documentation projects (applications and expert opinions). The values of indicators that can be worn and quantitative (e.g., the number of specialists involved in the project) and qualitative (e.g., the level of scientific validity used in the project of innovative solutions) character, it is advisable to convert the reduction to a single measuring point scale (from 0 to N points). For quantitative (numerical) indicators such conversion may be the assignment of a considered value to a particular subinterval (ballroom with a predetermined value) uneven partition of the interval of possible numerical values of the indicator. For qualitative (verbal) indicators the modification may be based on the use of offset (semantic differential) Osgood scale, wherein the minimum value (e.g., satisfactory) corresponds to 0 and the maximum possible value (for example, fine) -N points. Construction of non-uniform scale for quantitative and qualitative indicators of verbal assessment is made by experts.

In accordance with the Analytic Hierarchy Process Saaty (1980) and Bhushan *et al.* (2004) the values of evaluation criteria of each level (except the indicator level criteria) are defined as a linear convolution of criteria prior. Weighted convolution coefficients reflecting the relative importance of the criteria of the previous level are calculated by the method of ranking or paired comparisons on the basis of expert judgments.

Expert judgment changes in estimating projects: We call the change of expert opinions on the project elementary if it cannot be split into several other changes and any change of expert opinions is presented in the form of a consistent application of a few basic changes. It is easy to see that the basic positive (negative) change in the expert judgments about ballroom indicator values will be the increase (decrease) in value of one of one point indicators. At the same time we assume if the initial value of the indicator is equal to N (equal to 0), the positive (negative) change of expert judgment will not change the value of this indicator.

To determine the Basic Change of Expert Judgment (BCEJ) relative to the importance of the criteria we consider (as defined in Dmitriev and Lomazov (2014) the approach, based on the method of ranking. Let's consider the ordering a group of criteria based on ascending ranks (one group includes criteria with the same rank): $G_1, G_2,\dots, G_t$. G_j groups are non-empty, although some of them may consist of only one element. Under basic change of expert judgment within the ranking method we will understand the transition of some criterion f_k from one group G_j to another neighboring group G_{j-1} or G_{j+1}. Let the initial ranking criteria is: $r^0_1, r^0_2, \dots, r^0_n$. Minimum change in assessing the significance of the criterion of f_k upward or downward leads to a new ranking of $r_1, r_2, \dots, r_n$, the form of which depends on the value r^0_k and initial ranking overall. Suppose that under the initial ranking f_k criterion is part of a group of s other criteria $\{f_{k-1}, f_{k-2}, \dots, f_{k-s}\}$, having with them the same value r^0_k, rank and minimal (basic) increasing rank this criterion causes is the transition to the next-largest group $\{f_{k+1}, f_{k+2}, \dots, f_{k+t}\}$, containing a t-test of the same rank r^0_p. Moreover, in accordance with the rule of calculation of the ranks:

$$r^0_k = ((k\text{-}s)+(k\text{-}s+1)+\ldots+k)/(s+1) = (2k\text{-}s)/2$$
$$r^0_k+1 = ((k+1)+\ldots+(k+p))/p = (2k+p+1)/2$$

The transition to the next group test leads to new values of ranks:

$$r_{k\text{-}1} = ((k\text{-}s)+(k\text{-}s+1)+\ldots+k\text{-}1)/s+1 = (2k\text{-}s\text{-}1)/2$$
$$r_k = (k+(k+1)+\ldots+(k+p))/p = (2k+p)/2$$

Thus, as a result of minimum increasing of criteria significance f_k criteria:

- The criteria ranks of the first and second groups are reduced to 0.5
- The criterion f_k rank will increase the value of (p+s)/2
- The ranks of other criteria remain unchanged

The transition of f_k criterion to previous largest criteria group will lead to a corresponding criteria rank increase of the first and second groups in 0.5 and to the reduce in (p+s)/2 f_k criterion rank (ranks other criteria remain unchanged). The change in criteria ranks will lead to a change in their weights calculated using the formula (Saaty, 1980):

$$a_i = \frac{2(n+1-r_i)}{(n^2+n)}$$

RESULTS AND DISCUSSION

The procedure for the selection of projects, taking into account the possible changes of expert judgments in their estimation: The choice of liable to the implementation innovative project is produced by the person making the decision on the basis of the non-formalizable preferences (intuition, experience). Support management decision-making procedure is to reduce the set of all possible solutions to a set of final selection (Fig. 2).

In addition the account of the sensitivity of the expert judgments change is made on the basis of simulation computational experiment in which:

- A plurality of primary selection (number of projects with the best integrated assessments) is based on the available expert assessments
- Runs random generation of Basic Changes of Expert Judgment (BCEJ)
- Modified expert judgment builds a new set and combines it with the previous plurality of selection

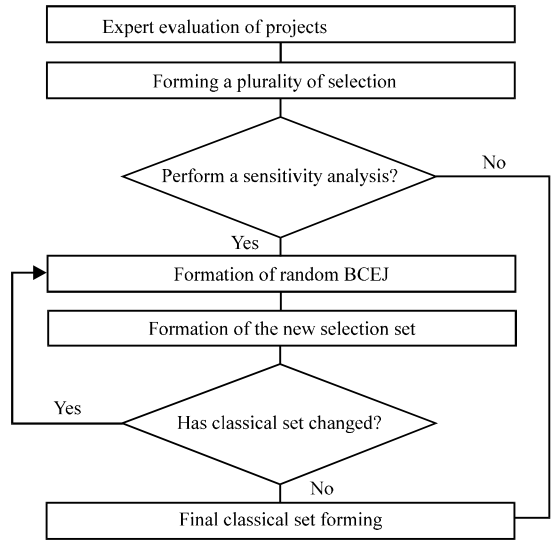

Fig. 2: The scheme of the procedure of final classical set forming of innovative projects

The procedure stops working when it reaches a predetermined number of iterations or in the absence of changes in the set after the selection of the next iteration and then select the set of declared final.

Software implementation: In accordance with the general approaches to the development and use of decision support software (Weistroffer *et al*., 2005), the proposed information models and algorithms for selecting innovative projects in the sphere of regional and municipal health program implemented within the framework of the specialized information-analytical system (AIS "SES-Research Healthcare"), structural and functional diagram is shown in Fig. 3. The system is designed on the base of block-modular principle and includes the following major subsystems:

- Information subsystem includes the following databases: applications, tender conditions and experts
- Algorithmic subsystem includes software modules, the methods of implementation and algorithms of modified assessments
- Interface subsystem provides the user with access to the authorization and differentiation, selection of significant coefficients, help and logging operations
- Visualization and mapping subsystem is used to display the results of processing graphically (Lomazov and Nesterova, 2015)

For a software implementation of a research prototype analytical-information system "SES-Research.

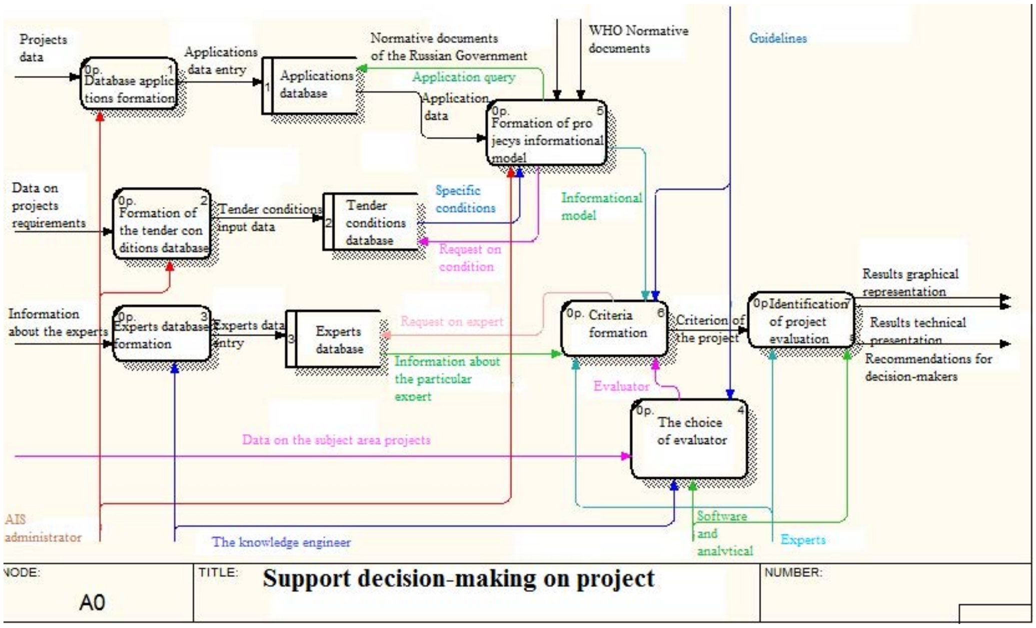

Fig. 3: Structural and functional IDEF1-chart AIS “SES-Research Healthcare”

Healthcare” the programming PHP 5 and MySQL 5.5.30 means were used. The choice of these tools has been largely due to its simplicity and speed of performance, feature-rich, cross-platform as well as its focus on the development of internet applications.

CONCLUSION

The approach to support decision-making on the selection of innovative projects proposed in the given article allows to consider possible changes to expert assessments, optimizes the validity increase of administrative decisions in the field of public health. Preliminary results of the proposed approach in the framework of a research prototype of information-analytical system of multi-criteria evaluation of innovative projects in healthcare are the evidence of its effectiveness. Further development of the proposed approach is expected in the direction of its use in a large number of performance indicators which will require the use of special methods of selection (for example, evolutionary techniques (Petrosov *et al*., 2015)) and the modification of the developed decision support system.

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