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Fuzzy-multiple Approach in Choosing the Optimal Term for Implementing the Innovative Project

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***Abstract*—A paper is devoted to the management of innovative projects based on the theory of fuzzy sets. To analyze project risks based on the terms of their implementation - acceleration, according to the plan and with the delay, authors proposed to employ both the asymmetry coefficient and the coefficient of asymmetry variation which are characterizing the asymmetric distribution of costs due to changes in the time interval of project implementation. On the basis of those coefficients above the fuzzy model was designed taking into account the duration of project implementation and the risks associated with the emergence of additional costs. Values of both coefficients are assigned in such way to meet the low, medium and high level of their performance. Fuzzy rules for assessing the feasibility of implementing the innovative project are developed. It's experimentally proofed the proposed fuzzy model gives a result that enables to get the optimal implementation period of the innovative project.**

Keywords—innovative project; fuzzy model; management; component; asymmetry coefficient; variation coefficient of asymmetry

I. INTRODUCTION

Nowadays, the project implementation is a necessary constituent of successful business, namely, an instrument which gives a company an opportunity to reach its strategic aims. According to the research results of Forbes Insights, 81% of respondents claimed that they considered the risk related to the new project implementation to be the most important thing, as the process of the development and financial results obtaining depends on the right choice of the activity strategy and the updating implementation term [1].

The strategic management of the projects is necessary for their successful introduction and maintaining of the high level of organization competitiveness [2]. For many companies, to remain in business, especially those depending on innovations, the key factor for maintenance of competitiveness consists in their ability to develop and introduce new products and processes. For these organizations, the method of estimation and the choice of the project are of crucial importance, as they are an inseparable function in the frame of the strategic management [3; 4]. The innovative project planning involves two stages: on the first one, the resources availability for all the works is estimated, on the second one, the priority combination of material resources and timing budget with the possibility to obtain the desired result is chosen.

There are different approaches to grounding the optimal terms of the project implementation in practice of management. Namely, they are mathematical (determined, stochastic programming, models with the elements of unexpectedness, using which it is possible to form the project portfolio); graphic approach; on the basis of the combination of financial and non-financial criteria; on the basis of aims hierarchy determination [5].

However, the dynamic development of modern project management, the speed of both scientific-and-technological advance, the growing competition predetermine the necessity of analyzing the external and internal factors of influence on the organization and planned project with the aim to determine the probability of their origin and expected costs. Therefore, the improving the selection of the priority project on the basis of risk comparing the additional financial, time and human resources, planned costs with the expected result, is important [6; 7].

II. PROPOSED FUZZY MODEL OF OPTIMAL TERM FOR PROJECT IMPLEMENTATION

To analyze the projects is expedient to take into account the risks related to their implementation terms: acceleration, according to the plan and delay time. For this purpose the use of both the asymmetry coefficient and the asymmetry variation coefficient is proposed. They characterize the asymmetric allocation of activity costs as a result of changing the time interval of its implementation. A deviation from the planned costs occurs as a result of unfavorable factors arising, namely:

1. General business (systematic) risk – depends on unfavorable terms;
2. Individual (non-systematic) risk – depends on the terms for a single project.

The reduction of implementing both projects terms and the time of investing, correspondingly, are the important factors for their efficiency increase. In order to select the priority project, taking into account the risks, related to the necessity to accelerate the implementation or postpone it is appropriate to conduct the estimation on the basis of the asymmetry coefficient and the asymmetry variation coefficient. It characterizes the asymmetric distribution of financial and time indexes for the activity effectiveness [8]. Taking into account the asymmetric allocation of activity costs, mentioned above, the asymmetry coefficient can be described by a modified formula:

$$As = \sum_{i-1}^{n} \left(\frac{B_i - B_j}{\delta^3} \right) * p_i , \quad (1)$$

where: B_i – the rate of costs in j-case; B_j – the expected most credible rate of costs; δ – root-mean-square deviation; p_i – the probability of j-case arising; n – the amount of possible cases.

In similar way, asymmetry variation coefficient

$$CVAs = \frac{1/(As+1)}{B_j}, \quad (2)$$

where: As – the asymmetry coefficient; B_j – the expected most credible rate of costs.

A forecasting provides the basis for any production activity. The ability to predict and estimate future events requires the study of imprecise data information coming from a rapidly changing environment, a task for which fuzzy logic is better suited to deal with than classical methods [9; 10].

The use of fuzzy systems is proposed to assess the qualitative composition of the studied information. Such an application makes it possible to create the distribution of source information at different stages of its appearing in order to evaluate it more accurately, study it in more detail and, accordingly, obtain the ultimate reliable management solution to solve practical tasks [11].

This issue is topical for every innovative project. During planning the time frame of development in general the focus is placed on standard terms of works carrying out. Accordingly, if they are executed within the established time limit, the project is as near as possible to the maximum efficiency. However, there is another limit of its expansion, namely, by means of changing the improvement field and works running. The reduction of implementation terms can be obtained as a result of the activity intensification with the help of additional resources involving. It means the increase of costs, which confirms its importance in the innovative process [12; 13]. And the additional duration of the work on the project is accompanied, as a rule, by the costs increase that is connected directly with the implementation time.

Therefore, in the situation of the risk for the successful project implementation under the conditions of indeterminacy, it is reasonable to employ the fuzzy logic tool. The last one provides the possibility to manage the risk on the basis of some probable values, approximate criteria, fuzzy prognosis and their interdependence in management [14; 15].

The whole process of fuzzy description for the management object is divided into the following stages: fuzzification (the value of the original variables transforms into the values of linguistic variable types by means of membership function) [16]; developing of fuzzy rules that connect linguistic variables and defuzzification (the transition from fuzzy values of the variables to established parameters) [17; 18].

Thereby the proposed model of the optimal term for the project implementation takes into account the risks related to the time frame of its implementation and is based on two criteria: the asymmetry coefficient according to (1) and the asymmetry variation coefficient according to (2). The selection subsystem is based on Mamdani algorithm. The output of such subsystem is the project evaluation (Result) on the basis of risks connected with the implementation time change and additional costs arising.

III. Study of Proposed Fuzzy Model

The proposed model is explored experimentally on the basis of Fuzzy Logic Toolbox in the environment of MATLAB 7.10.0 (R2010a) taking into account the project implementation time and the risks connected with the additional costs arising. Thus, the values of membership function of input variables As and CVAs are assigned by trapezoidal function which is determined by four numbers that mark the trapeze vertices abscissas. They are divided into three intervals each one for the exact description of variables, in particular, to describe the variation level of the asymmetry coefficient of costs change the variable “small” is used. It specifies the low level (if the project implementation time does not influence the total value of the project), “middle” specifies the middle level and “high” is for the high level (if the changes of project implementation time considerably increase its cost and influence its performance)

In theory, the asymmetry coefficient does not have any limits. However, in practice, its value is not too high and does not exceed “one” in medium slanted distributions (Fig. 1). It is considered that if the asymmetry coefficient is less than 0,25, the asymmetry is small, if it does not exceed 0,6 – the asymmetry is middle, if it is more than 0,5 – the asymmetry is high [19].

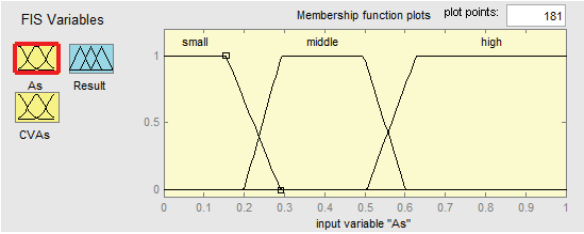

Figure 1. Membership function of As coefficient.

For the membership function CVAs it is considered that the closer the asymmetry coefficient to zero is, the better. For the level assigning of the asymmetry variation coefficient the following variables are proposed: small – (0; 0,17], middle – [0,9; 0,45] and high – [0,4; 1], which correspond to low, middle and high level.

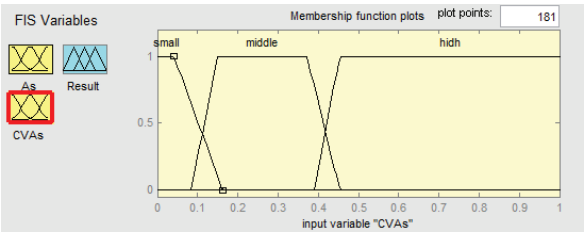

Figure 2. Membership function of CVAs coefficient.

The output membership function Rezult is assigned by trapezoidal shape (Fig. 3). The value intervals of the obtained result (0; 0,2] are represented by “Yes” variant, which means the reasonability of the innovative project implementation. The interval limits [0,15; 0,6] are represented by “Maybe” variant. This answer determines the necessity to analyze additionally the innovative project taking into account other factors which can be crucial at decision making about its reasonability and effectiveness. The interval limits [0,5; 1] are represented by variant “No”, which means the inexpediency of the innovative project implementation on the basis for comparison of time and costs indexes.

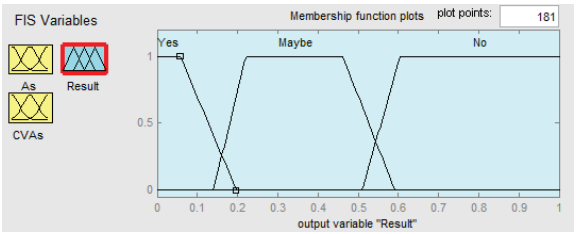

Figure 3. Membership function of Result.

The knowledge database for the construction of such a fuzzy model consists of 9 rules of the type “if - then”. All the input variables have three fuzzy states, and the result represents three variants of the estimation for the project implementation reasonability (Table I).

TABLE I. RULES OF FUZZY LOGIC FOR THE PROJECT IMPLEMENTATION REASONABILITY

Value of asymmetry coefficient (As)	Value of asymmetry variation coefficient (CVAs)	Estimation of project implementation reasonability (Result)
small	small	Yes
small	middle	Yes
small	high	Maybe
middle	small	Yes
middle	middle	Maybe
middle	high	No
high	small	Maybe
high	middle	No
high	high	No

The fuzzy conclusion of the decision making during the innovative project implementation is represented in the Fig. 4. For example, investigating an innovative project on the basis for its duration, the amount of planned expenses and the variants for acceleration and postponing of the project implementation, the coefficient of asymmetry of 0,317 is obtained. The asymmetry variation coefficient makes 0,141 correspondently and enters the fuzzy limits. The result obtained on the basis of the developed membership function makes 0,333, which corresponds to the variant “Maybe”.

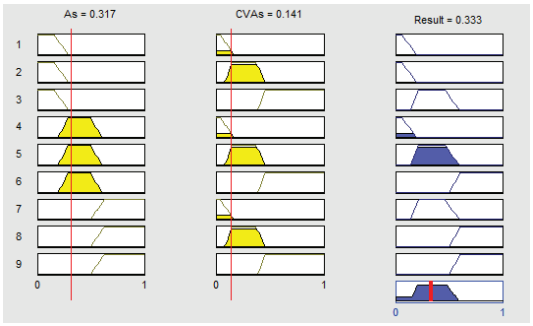

Figure 4. The rule base of fuzzy model for reasonability of implementating the project depending on existent risks.

It can be seen from the surface for the developed fuzzy model of assessing the project implementation reasonability and priority on the basis of Mamdani algorithm (Fig. 5), that correctness of fuzzy rules database construction is confirmed.

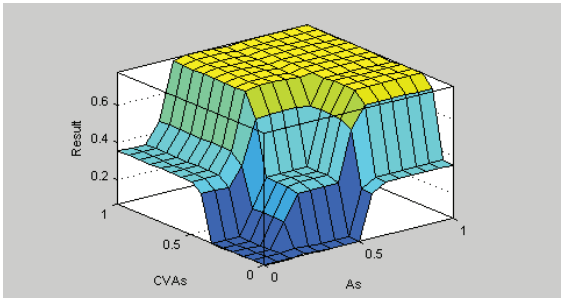

Figure 5. A graphical interpretation of fuzzy assessment model.

As it is evident from the foregoing, the employed software enables to implement the fuzzy model with the aim to make the reasonable administrative decision. Note that in this case the risks, connected with the costs and the profit generation are taken into account. It covers a wide range, starting from measuring the internal business processes, which can cause certain risks arising, to achieving the financial and economic aims in the given field.

Moreover the developed fuzzy model contributes to the effectiveness improvement of innovative projects, as it implies the mathematical background of management decisions, and reduction of the human factor influence as well as time economy and utility.

Also the model enables to estimate numerical indexes in a more correct way, as it takes into account the fuzzy limits of small, middle and high level of both the asymmetry coefficient and the asymmetry variation coefficient.

The main objective of the practical implementation of the proposed model is to assess the risks and potential profitability of the innovative projects for business development. Such result enables to take managerial decisions of internal and external direction, improve the marketing strategies. The developed model can be applied in implementing the innovative projects at the enterprises which:

- implement the short-term projects (the relevance of the implementation affects the final financial result of the project and the operation of the company as a whole);
- operate under the condition of severe competition (the time limits of the project implementation affect the ability to promote goods or services on the market and the ability to take a competitive niche among the customers);
- depend on the seasonality of production (seasonality creates time limits for the practical use of the project because the failure to comply with the terms will lead to additional expenses).

IV. CONCLUSIONS

Authors developed the fuzzy model of the project priority assessment counting the both asymmetry and asymmetry variation coefficients of the risks connected with the term of project implementation and accompanying costs.

The proposed model enables to select the optimal term for developing and implementing the project taking into account the external and internal influence factors, as well as to increase the efficiency of project implementation. This model contributes to the effectiveness improvement of innovative projects, as it implies the mathematical background of management decisions, and reduction of the human factor influence as well as time economy and utility.

REFERENCES

[1] *Exploring Strategic Risk.* https://www2.deloitte.com/ua/en/pages/governance-risk-and-compliance/articles/exploring-strategic-risk.html. Last accessed 15.02.2017.

[2] G. Kendall, S. Rollins, "Advanced project portfolio management and the PMO: Multiplying ROI at warp speed," *J. Ross Publishing*, pp. 69–79, 2003.

[3] P. Kossakowski, P. Bilski, "Analysis of the self-organizing map-based investment strategy," *International Journal of Computing*, vol. 16, issue 1, pp. 10-17, 2017.

[4] N. Furr, J. Dyer, "Choose the right innovation method at the right time," *Harvard Business Review*, 2014, [Online]. Available: https://hbr.org/2014/12/choose-the-right-innovation-method-at-the-right-time.

[5] A. Paolini, M. Glaser, "Project selection methods that pick winners," *Research Management*, pp. 26-29, 2016.

[6] M. Coffin, B. Taylor, "Multiple criteria R&D project selection and scheduling using fuzzy logic," *Computers & Operations Research*, vol. 23, issue 3, pp. 207–220, 1996.

[7] L. Meade, A. Presley, "R&D project selection using the analytic network process," *IEEE Transactions on Engineering Management*, vol. 49, issue 49, pp. 59–66, 2002.

[8] M. Mian, *Project Economics and Decision Analysis: Probabilistic Models*, PennWell Books, 2011, pp. 66–67.

[9] J. V. Bezdek, "Using fuzzy logic in business," *Procedia – Social and Behavioral Sciences*, vol. 124, pp. 371–380, 2014.

[10] K. Shang, Z. Hossen, *Applying Fuzzy Logic to Risk Assessment and Decision Making*, Casualty Actuarial Society, Canadian Institute of Actuaries, Society of Actuaries, 2013, 59 p.

[11] T. Lendyuk, S. Sachenko, S. Rippa, G. Sapojnyk, "Fuzzy rules for tests complexity changing for individual learning path construction," *Proceedings of the 8th IEEE International Conference on Intelligent Data Acquisition and Advanced Computing Systems: Technology and Applications (IDAACS'2015)*, Warsaw, Poland, 24-26 September 2015, pp. 945-948.

[12] R. Doskocil, "An evaluation of total project risk based on fuzzy logic," *Business: Theory and Practice*, vol. 17, pp. 23–31, 2016.

[13] S. Fraser, M. Bojadziev, *Fuzzy Logic for Business, Finance, and Management*, World Scientific, 2007, 233 p.

[14] A. S. Ptuskin, *Fuzzy Models and Methods in Management*, Moscow, MSTU them. Bauman, 2008, 216 p. (in Russian)

[15] L. Machacha, P. Bhattacharya, "A fuzzy-logic-based approach to project selection," *IEEE Transactions on Engineering Management*, vol. 47, issue 1, pp. 65–73, 2000.

[16] Y. P. Kondratenko, Ie. V. Sidenko, "Decision-making based on fuzzy estimation of quality level for cargo delivery," in book: *Recent Developments and New Directions in Soft Computing. Studies in Fuzziness and Soft Computing*, L. A. Zadeh, et al. (Eds), Springer International Publishing Switzerland, pp. 331–344, 2014.

[17] T. J. Ross, *Fuzzy Logic with Engineering Applications*, McGraw-Hill Inc., 1995, pp. 90–112.

[18] S. Shtovba, Introduction to the Theory of Fuzzy Sets and Fuzzy Logic, [Online]. Available: http://matlab.exponenta.ru/fuzzylogic/book1/.

[19] G. Boshnakov, *Some Measures for Asymmetry of Distributions*, Mathematics Department University of Manchester Institute of Science and Technology, 2006, pp. 2–8.