THE PROJECTS EVALUATION AND SELECTION BY USING MCDM AND INTUITIONISTIC FUZZY SETS

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Abstract:

The process of project evaluation and selection is essential in many companies, especially in information technology (IT) organizations. The objective of this research is to propose a two-stage multi-attribute decision-making (MADM) model combined with intuitive fuzzy sets (IFs) to evaluate and select projects concerning predefined criteria. In the first stage, the fuzzy pairwise comparison matrix of the criteria's relative importance is constructed. The fuzzy weights vector of criteria is determined by using AHP extended with IFs. In the second step, the MABAC extended with IFs is proposed and applied for ranking the considered alternatives, in this case, projects. The proposed methodology enables rejection of the considered project proposals if they do not meet any defined criteria. In this way, the rank of the treated project proposals is determined at the level of each group of treated criteria, so the decision-makers can have the final call on the selection of project funding and execution. The model is tested on real-life data from an IT company operating in the Republic of Serbia.

Keywords: project management, intuitionistic fuzzy set, IF-AHP, F-MABAC

1. Introduction

In the IT sector, most companies design their organization to be project-based. The functioning of these companies is determined by ongoing project selection and their execution, so their employees are seeking new project opportunities constantly. In this situation, there can be an accumulated long list of potential projects that can be realized. However, it should be mentioned that each organization has limited resources, so they need to choose the projects wisely as they usually strive to lean operations [1].

The Project Portfolio Selection can be very complex [2]. Also, the decision that is made today will determine the allocation of resources in the future so the project selection can be analysed from the perspective of the companies' sustainability [3]. It is inevitable to conclude that it is much more convenient to develop an appropriate project portfolio than to randomly select projects for execution.

The goal of this research is to provide a reliable model for the projects' evaluation and selection. In the past few years, the level of uncertainty has increased in business terms all over the world caused by the pandemic and geopolitical issues. These new conditions seek to employ different models in business that can handle uncertainty which is also applicable to project management issues [4]. The motivation of this research is to enhance the pool of models that are used for the evaluation and selection of projects that are capable of handling uncertainties efficiently. To do so, two MADM models are combined and extended with IFs.

2. Methodology

The projects' evaluation and selection represent one of the most strategic management tasks involving different managers as the decision-makers. The number of projects that are going to be selected to be adjoined to the project's portfolio is presented by a set of indices $\{1,\ldots,i,\ldots,I\}$. The total number of identified investment projects is denoted as I, and $i, i=1,\ldots,I$ is the index of the project. In the general case, investment projects can be estimated concerning criteria groups, which can be formally represented by a set of indices $\{1,\ldots,k,..,K\}$. The total number of criteria groups is denoted as K. The index of the criteria group is $k, k=1,\ldots,K$. These criteria groups consist of many criteria which can be presented by a set of indices $\{1,\ldots,j,\ldots,J\_k\}$. The total number of criteria under the criteria group $k, k=1,..,K$ is denoted as J_k, and $j, j=1,\ldots,J\_k$ is the index of criterion.

In this research, the assessment is performed in compliance with the criteria defined by Pinto [5] which are presented Table 1.

Risk–unpredictability to the firm (k=1)	**Commercial–market potential (k=2)**
Technical (j=1) Financial (j=2) Safety (j=3) Quality (j=4) Legal exposure (j=5)	Expected return on investment (j=1) Payback period (j=2) Potential market share (j=3) Long-term market dominance (j=5) Initial cash outlay (j=6) Ability to generate future business/new markets (j=7)
Internal operating–changes in firm operations (k=3) Need to develop/train employees (j=1) Change in workforce size or composition (j=2) Change in physical environment(j=3) Change in manufacturing or service operations (j=4)	**Additional (k=4)** Patent protection (j=1) Impact on company's image (j=2) Strategic fit (j=3)

Table 1 Criteria in project screening and selection

In the problem, the assumption is introduced: (i) the relative importance of criteria under each criterion group does not have equal importance and it is presented by the fuzzy pair-wise comparison matrix, (ii) the criteria under criterion groups are a benefit type and cost type; criteria values are assessed by DMs who use natural language expressions.

Uncertainties that exist in the model such as relative importance criteria and their values are assessed by DMs. Respecting the nature of human thinking, it can be argued that DMs express their assessments better by using natural language words instead of precise numbers. In this paper, modelling of predefined linguistic statements is based on TrIFNs [6].

All the considered criteria for evaluating investment projects have different relative importance which can be considered unchangeable during the considered period. The relative importance of the criteria is assessed by the decision-making team (chief executive officer, marketing manager, chief operating officer, chief information officer). The decision-making team is in charge of the assessment of the criteria values too. The elements of the fuzzy pairwise comparison matrix of the relative importance of criteria are described by five different pre-defined linguistic expressions corresponding to TrIFNs. The overlap of TrIFNs describing the relative importance of criteria is large. This indicates a lack of knowledge of DMs about the importance of the considered criteria.

The proposed algorithm can be summarized as presented in figure 1. The proposed model consists of two stages. A further description of the model is applied to each group of the treated criteria.

The first stage starts with defining a fuzzy pairwise comparison matrix. This matrix is transformed into a pairwise comparison matrix by using the defuzzification procedure [7]. Checking of the DMs' assessment consistency is performed by using the Eigenvector method [8]. Determining the weights vector of criteria is based on fuzzy algebra rules [6] and the procedure defined by Buckley [9].

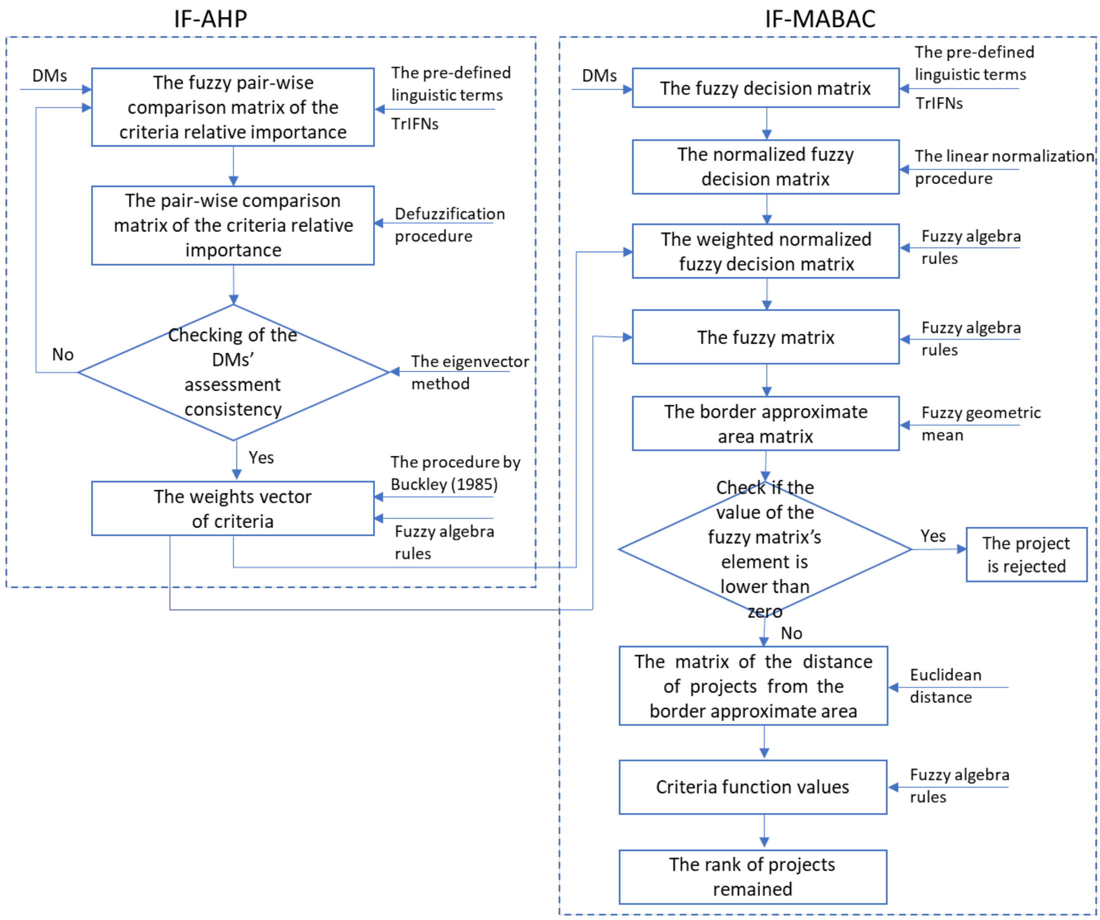

Figure 1 – The proposed two-stage research model

The second stage is used for determining the projects' rank by using the extended MABAC method [10] with TrIFNs. The proposed method is executed in more steps compared to the conventional one due to the specificity of TrIFNs mathematical operations. The treated criteria are const and benefit type, so the normalization procedure is applied. The elements of the weighted normalized fuzzy decision matrix are calculated as a product of the criteria weight and the normalized value. The fuzzy matrix is constructed as the sum of the weights vector and the weighted normalized fuzzy decision matrix. The new procedure is developed to check whether alternatives belong to the border approximate areas. If the value of the fuzzy matrix's element is lower than zero, then the project is rejected. The rest of the projects are further considered. The value of the criteria function is calculated as a sum of the distance between the two TrIFNs. Those TrIFNs describe the values of fuzzy matrix elements and the values of the border approximate area matrix. The project with the highest value adjoined is ranked as number one.

3. Conclusions

The proposed model is tested on real data from company operating in the IT sector in the Republic of Serbia. The input data is obtained through collaboration with the team of decision-makers from the company as suggested in the description of the two-stage model. At the level of each considered group of the treated criteria, the rank of the projects is obtained. As the rank is obtained at the level of each four criteria groups, the decision-makers should determine which project will be selected for realization.

The main theoretical contribution comes from the modification of the MABAC method in terms of checking if the considered alternative belongs to the border approximate areas. Due to the nature of the considered problem, if the alternative belongs to the lower border approximate area, this alternative is rejected.

Future research will include the analysis of different methods for determining the most suitable project for funding, taking into account the considered criterion groups.

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