Analysis of Project Selection by Using SDV-MOORA Approach

Mohamed F. El-Santawy[1,*] and A. N. Ahmed[2]

[1]Department of Operation Research, Institute of Statistical Studies and Research (ISSR)
Cairo University, Egypt
*Corresponding author: lost_zola@yahoo.com
[2]Department of Mathematical Statistics, Institute of Statistical Studies and Research (ISSR), Cairo University, Egypt

Abstract: Various objectives are usually taken into account when projects are analyzed, including economic desirability, technical issues, and environmental and social factors. As the decision maker tries to maximize or minimize outcomes associated with each objective depending on its nature, so a Multi-Criteria Decision Making (MCDM) problem arises. In this article, a new method is developed to assign weights to criteria when there is no preference among them based on the Standard Deviation (SDV) and Multi-Objective Optimization on the basis of Ratio Analysis (MOORA) technique. A MCDM project selection problem found in real-life international company is presented.The new approach so-called SDV-MOORA is employed to solve the MCDM problem.
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1. Introduction

Effective and efficient selection of projects has a vital significance in every organization. The decision making process is highly complex as it is to assess the appropriateness of a given project, estimate its value and justify it from an engineering standpoint. Selection of a project or a portfolio of projects constitutes one of the main problems that managers are faced with. Profitable investments lead to the growth and prosperity of each corporation. Various objectives are usually taken into account when projects are analyzed, including economic desirability, technical issues, and environmental and social factors. It should be noticed that evaluation criteria could be of various nature. While financial measures (Net Present Value, Rate of Return, Payback Period, and Project Risk) are of quantitative type, the ones that reflect technical, environmental or social objectives are usually of qualitative nature [5].

The MCDM includes many solution techniques such as Simple Additive Weighting (SAW), Weighting Product (WP) [9], and Analytic Hierarchy Process (AHP) [12]. The problem of allocating the weights of criteria when no preference is an open research area. Many scholars tried to tackle this problem by various techniques like Information Entropy Weight method, the weighted average operator (OWA), and other several methods [6,7].

In this paper a project selection problem existed in a multi-national company is presented. The Technique called Multi-Objective Optimization on the basis of Ratio Analysis (MOORA) method, a branch of MCDM methods, is applied to rank the projects. The Standard Deviation (SDV) method is introduced for allocating the weights of criteria of selection. This paper is structured as following: Section 2 is made for the MOORA approach, section 3 is devoted to the proposed Standard Deviation method, the case study of a project selection problem is illustrated in section 4, and finally in section 5 conclusion is introduced.

2. MOORA

A MCDM problem can be concisely expressed in a matrix format, in which columns indicate criteria (attributes) considered in a given problem; and in which rows list the competing alternatives. Specifically, a MCDM problem with m alternatives (A_1, A_2, ..., A_m) that are evaluated by n criteria (C_1, C_2, ..., C_n) can be viewed as a geometric system with m points in n-dimensional space. An element x_{ij} of the matrix indicates the performance rating of the ith alternative A_i, with respect to the jth criterion C_j, as shown in Eq. (1):

$$D = \begin{array}{c} \\ A_1 \\ A_2 \\ A_3 \\ \vdots \\ A_m \end{array} \begin{array}{c} \begin{array}{ccccc} C_1 & C_2 & C_3 & \cdots & C_n \end{array} \\ \left[\begin{array}{ccccc} x_{11} & x_{12} & x_{13} & \cdots & x_{1n} \\ x_{21} & x_{22} & x_{23} & \cdots & x_{2n} \\ x_{31} & x_{32} & x_{33} & \cdots & x_{3n} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ x_{m1} & x_{m2} & x_{m3} & \cdots & x_{mn} \end{array} \right] \end{array} \quad (1)$$

Brauers first introduced the MOORA method in order to solve various complex and conflicting decision making problems [4]. The MOORA method starts with a decision matrix as shown by Eq. (1). The procedure of MOORA for ranking alternatives can be described as following:

Step 1: Compute the normalized decision matrix by vector method as shown in Eq. (2)

$$x^*_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}}, \quad i = 1,...,m; j = 1,...,n. \tag{2}$$

Step 2: Calculate the composite score as illustrated in Eq. (3)

$$z_i = \sum_{j=1}^{b} x^*_{ij} - \sum_{j=b+1}^{n} x^*_{ij}, \quad i = 1,...,m. \tag{3}$$

where $\sum_{j=1}^{b} x^*_{ij}$ and $\sum_{j=b+1}^{n} x^*_{ij}$ are for the benefit and non-benefit (cost) criteria, respectively. If there are some attributes more important than the others, the composite score becomes

$$z_i = \sum_{j=1}^{b} w_j x^*_{ij} - \sum_{j=b+1}^{n} w_j x^*_{ij}, \quad i = 1,...,m. \tag{4}$$

where W_j is the weight of jth criterion.

Step 3: Rank the alternative in descending order.
Recently, MOORA has been widely applied for dealing with MCDM problems of various fields, such as economy control [3], contractor selection [2], and inner climate evaluation [10].

3. Standard Deviation for allocating weights
In this paper, the well known standard deviation (SDV) is applied to allocate the weights of different criteria. The weight of the criterion reflects its importance in MCDM. Range standardization was done to transform different scales and units among various criteria into common measurable units in order to compare their weights.

$$x'_{ij} = \frac{x_{ij} - \min_{1 \leq j \leq n} x_{ij}}{\max_{1 \leq j \leq n} x_{ij} - \min_{1 \leq j \leq n} x_{ij}} \tag{5}$$

$D' = (x')_{mxn}$ is the matrix after range standardization; max x_{ij}, min x_{ij} are the maximum and the minimum values of the criterion (j) respectively, all values in D' are ($0 \leq x'_{ij} \leq 1$). So, according to the normalized matrix $D' = (x')_{mxn}$ the standard deviation is calculated for every criterion independently as shown in Eq. (6):

$$SDV_j = \sqrt{\frac{1}{m}\sum_{i=1}^{m}(x'_{ij} - \bar{x'}_j)^2} \tag{6}$$

where $\bar{x'}_j$ is the mean of the values of the jth criterion after normalization and $j = 1,2,...,n$.
After calculating (SDV) for all criteria, the weight (W_j) of the criterion (j) can be defined as:

$$W_j = \frac{SDV_j}{\sum_{j=1}^{n} SDV_j} \tag{7}$$

where $j = 1,2,...,n$.

4. Project Selection Problem
Numerous techniques have been proposed in recent years for solving project selection problems. Heidenberger and Stummer give a survey of quantitative techniques for R&D project selection and resource allocation problems [8]. Most of procedures listed in that paper can be applied for evaluating construction and engineering projects as well. Utility function approach is often employed for solving such a problem. E.g., in [11] and [13] this methodology is used.
Project selection problem is a typical MCDM problem which involves both quantitative and qualitative criteria to be considered. In the rest of this section, some of the quantitative criteria will be illustrated. Also, in our case study, we will limit comparison to these four criteria. The considered criteria are described in brief as following [1]:

First Net Present Value
The Net Present Value (NPV) is defined as the sum of the present values (PVs) of the individual cash flows. Actually, NPV is an indicator of how much value a project adds to the organization. Therefore, it is treated as the benefit criteria of the project. In financial theory, if there is a choice between two mutually exclusive alternatives, the one yielding the highest NPV should be selected.

Second Rate of Return
Rate of Return (ROR) is the ratio of money gained or lost on a project relative to the amount of money invested. ROR is usually expressed as a percentage. Therefore, ROR is also the benefit criteria for any project selection.

Third Payback Period
Payback period (PB) is the period required for the return on an investment or project. Any project yielding the quickest Payback Period should be selected.

Fourth Project Risk
There may be some external circumstances or event that cannot occur for the project to be successful.

The external events are called Project Risks (PR). If such type event were likely to happen, then it would be a risk. The aim of project selection is to minimize the risk criteria. In the problem considered the risks associated to projects are scaled from 1 to100.

In the rest of this section, a real-life project selection problem existing in multi-national company will be illustrated and solved by the proposed technique. The company's management limited the criteria compared to be eight. All the criteria are from the quantitative type and have financial aspects. The company made market research and feasibility studies to stand over the values and performance ratings with respect to the considered criteria. Some values are extracted from the company financial statements (like cash flow statement, balance sheet). The values of fourth criterion (Project Risk) are analyzed by specialized organization. The problem has five projects to be ranked through comparing four criteria. As shown in Table 1, the considered criteria, their computational units, their utility type (Max or Min), and their relevant weights assigned by management are presented. After, Table 2 shows the five projects and their performance ratings with respect to all criteria.

Table 1. Criteria and their computation units

Criterion Index	Criterion Description	Units	Utility Type
C_1	Net Present Value (NPV)	L.E (Millions)	Max
C_2	Rate of Return (ROR)	L.E (Millions)	Max
C_3	Payback Period (PB)	Months	Min
C_4	Project Risk (PR)	Points (1-100)	Min

Table 2. Decision matrix

Index	C_1	C_2	C_3	C_4
Project 1	35.53	8.26	11	77
Project 2	50.91	15.66	15	59
Project 3	66.24	32.57	9	83
Project 4	15.69	9.73	19	61
Project 5	25.31	14.56	16	58

In the above example, the Standard Deviation method is employed to allocate the weights. Table 3 illustrates the range standardization done to decision matrix as in Eq.(5).

Table 3: Range standardized decision matrix

Index	C_1	C_2	C_3	C_4
Project 1	0.392	0	0.2	0.76
Project 2	0.697	0.304	0.6	0.04
Project 3	1	1	0	1
Project 4	0	0.06	1	0.12
Project 5	0.19	0.259	0.7	0

Table 4 shows the values of the Standard Deviation (SDV_j), and the weight assigned to each criterion (W_j) as shown in Eqs. (6 and 7). The weights' assignment process is very sensitive which will be reflected on the final ranking of the alternatives.

Table 4: Weights assigned to criteria

	SDV_j	W_j
C_1	0.3989	0.240249
C_2	0.3987	0.240161
C_3	0.4	0.240917
C_4	0.4627	0.278674

By applying the procedure of MOORA, the normalized decision matrix found in Table 3 is used. In Table 5, the benefit, cost, and composite scores are listed for all alternatives. The third project should be selected because it has the maximum composite score.

Table 5: Ranking lists and scores

	Benefit criteria	Cost criteria	Composite score	Rank
Project 1	0.07284224	0.2028	-0.1299781	4
Project 2	0.19708469	0.1140	0.08310971	2
Project 3	0.40824362	0.2208	0.18749086	**1**
Project 4	0.01346342	0.2017	-0.1882684	5
Project 5	0.09302003	0.1227	-0.029649	3

5. Conclusion

In this paper, a new method to solve MCDM problems is presented and illustrated. A real-life project selection problem of a new manner existing in multi-national company is introduced. The Standard Deviation (SDV) is incorporated to Multi-Objective Optimization on the basis of Ratio Analysis (MOORA) technique in order to determine weights when no preference exists. It might be combined to other MCDM techniques in further research.

Corresponding Author:
Mohamed Fathi El-Santawy
E-mail: lost_zola@yahoo.com

References
1. Bakshi, T., Sinharay, A. and Sarkar. B. (2011). Exploratory Analysis of Project Selection through MCDM. *In the Proceedings of the 10th International Conference on Operations and Quantitative Management (ICOQM-10)*, June 28–30, 2011, Nashik, India, pp. 128–133.
2. Brauers, W. K. M. (2008), "*Multi-objective contractor's ranking by applying the MOORA method*", Journal of Business Economics and Management, 2: 245–255.
3. Brauers, W. K. M. and Zavadskas, E. K. (2006), "*The MOORA method and its application to privatization in a transition economy*", Control and Cybernetics, 35(2): 445–469.
4. Brauers, W. K. M. (2004), Optimization methods for a stakeholder society, A revolution in economic thinking by multiobjective optimization, Boston: Kluwer Academic Publishers.
5. El-Santawy, M. F. and Ahmed, A. N. (2012), "*A VIKOR Approach for Project Selection Problem*", Life Science Journal, Marsland Press, 9(4):5878–5880.
6. El-Santawy, M. F. (2012), "*A VIKOR Method for Solving Personnel Training Selection Problem*", International Journal of Computing Science, ResearchPub, 1(2): 9–12.
7. El-Santawy, M. F. (2012), "*Personnel Training Selection Problem Based on Modified TOPSIS*", Computing and Information Systems Journal, University of the West of Scotland, 16(1): 92–97.
8. Heidenberger, K. and Stummer, Ch. (1999). Research and Development Project Selection and Resource Allocation: a Review of Quantitative Modelling Approaches. *International Journal of Management Reviews*, 1 : 197–224.
9. Hwang, C.L. and Yoon, K. (1981), Multiple Attributes Decision Making Methods and Applications, Heidelberg: Springer, Berlin.
10. Kalibatas, D. and Turskis, Z. (2008), "*Multi-criteria evaluation of inner climate by using MOORA method*", Information Technology and Control, 37: 79–83.
11. Moselhi, O. and Deb, B. (1993). Project Selection Considering Risk. *Construction Management and Economics*, 11: 45–52.
12. Saaty, T.L. (1980), The Analytic Hierarchy Process, McGraw-Hill, New York.
13. Wong, E.T.T., Norman, G. and Flanagan, R. (2000). A Fuzzy Stochastic Technique for Project Selection. Construction Management and Economics, 18: 407–414.

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