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Selection of Project Firm by Utilizing Entropy and Topsis Methods

Engineering

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Orkun ALPTEKİN Dr.Eskisehir Osmangazi University, Eskisehir, Turkey

ABSTRACT

In the construction sector, construction and manufacturingaffairscan be carried outin a healthy way by the correct preparation of projects which define the construction works. Correct preparation of projects depends on the characteristics of the project firm. Therefore, the selection of the most appropriate project firm is an important issue. In this article TOPSIS method is proposed as a tool to select the best project firm in preparing the projects wealthy. The TOPSIS method allows to decision makers to express their opinions about the criteria. In this article, four project firms are compared according to criteria: bid, similar work experience, current workload and number of qualified staff with TOPSIS method.

INTRODUCTION

Construction bidding is the process of submitting a tender to undertake, or manage the undertaking of a construction project. The process starts with a cost estimate from the projects of construction work. The tender is treated as an offer to do the work for a certain amount of money or a certain amount of profit which is calculated by survey of projects [1].So for success of construction the correct preparation of projects which define the construction works is very important.Correct preparation of projects depends on the characteristics of the project firm. Therefore, the selection of the most appropriate project firm for the project is an important issue.

In Turkey public agencies, projects which consist with architectural, static, mechanical and electric projects can be prepared by two methods. One of them is agencies who have enough qualified technical staff, draw them in its own. The other one is by supplying them using various tender methods which are determinate by Public Procurement Law [2]. In tender methods, agencies identify an appropriate list of evaluation criteria, requirement list and proposes a quantitate procedure for building construction projects. Then project executivecommittee who research prices of all projects to determine the approximate cost of work. Project firms who have the requirements that are specifiedin tender documents submit their proposals which contain price they offer. The firm who offer the lowest bid price wins the tender and takes the project work [3].In selection process selecting the firms by only determining the prices may affect the quality of work [4, 5].There are also other criteria as similar work experience, current work load of firm, experience and number of qualified staffthat should be considered. When there are a lot of criteria to evaluate decision makers need a model to perform the best selection. There are methods which are simultaneouslyevaluatingdifferent criteria. Some of them are multi-criteria decision-making (MCDM), multi-attribute analysis (MAA), multi-attribute utility theory (MAUT), multiple regression (MR), cluster analysis (CA), bespoke approaches (BA), fuzzy set theory (FST) and multivariate discriminant analysis (MDA) [5-8].

Project firm selection is one of the most important steps of project management that has a significant role to achieve both short and long term goals of construction and manufacturing. It is a multi-criteria decision-making problem which has several factors to be considered. The most commonly used multi criteria decision methods are Weighted Sum Method, Weighted Product Method, Analytical Hierarchy Process, PROMETHEE, ELECTRE and TOPSIS methods [9-11]. All these methods aim at using a set of criteria which may vary in the degree of importance for a decision problem. In this paper the TOPSIS approach is proposed as a tool to select the best project firm to draw the projects and prepare the bid documents. In determining the degree of importance of each criterion, ENTROPY method is used.

MATERIALS AND METHODS

In this section, methodologies of Entropy and TOPSIS methods are given. And then, the project firm selection problem is structured.

TOPSIS Method

Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) was proposed by Hwang and Yoon in 1981. TOPSIS finds the best alternatives by minimizing the distance to the ideal solution and maximizing the distance to the positive or negative ideal solution [12]. All alternative solutions can be ranked according to their closeness to the ideal solution. Because its first introduction, a number of extensions and variations of TOPSIS have been developed over the years. General TOPSIS process with six steps is listed below [13]:

Step 1. Construction of the decision matrix

TOPSIS Method builds on the assumption that decision matrix D includes *m* alternatives and *n* criteria as follows:

$$D = \begin{array}{c} A_1 \\ A_2 \\ \vdots \\ A_m \end{array} \begin{bmatrix} x_1 & x_1 & \dots & x_{1n} \\ x_1 & x_2 & \dots & x_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ x_{m1} & x_{m2} & \dots & x_m \end{bmatrix} \quad [1]$$

The decision matrix is normalized by vector normalization as shown in below:

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}}, \; i = 1,\dots,m; \; j = 1,\dots,n \quad [2]$$

This results normalized decision matrix as follows.

$$R = \begin{bmatrix} r_{11} & r_{12} & \dots & r_{1n} \\ r_{21} & r_{22} & \dots & r_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ r_{m1} & r_{m2} & \dots & r_{mn} \end{bmatrix}_{m \times n} \quad [2]$$

Step 3. Weighted normalized decision matrix is formed as:

$$v_{ij} = w_i * r_{ij}, \; i = 1,\dots,m; \; j = 1,\dots,n. \quad [4]$$

Step 4. PIS (positive ideal solution) and NIS (negative ideal solution) are determined as:

$A^+ = (v_1^+, v_2^+, \ldots, v_j^+, \ldots, v_n^+)$ maximum values, [5]

$A^- = (v_1^-, v_2^-, \ldots, v_j^-, \ldots, v_n^-)$ minimum values. [6]

Step 5. The distance of each alternative from PIS and NIS is calculated as:

$$d_i^+ = \sqrt{\sum_{j=1}^{n}(v_{ij} - v_j^+)^2}, \quad i = 1,2,\ldots,m. \qquad d_i^- = \sqrt{\sum_{j=1}^{n}(v_{ij} - v_j^-)^2}, \quad i = 1,2,\ldots,m.$$

[7]

Step 6. The closeness coefficient of each alternative (CC_i) is calculated as:

$$CC_i = \frac{d_i^-}{d_i^+ + d_i^-}. \qquad [8]$$

Step 7. The ranking of alternatives is determined by comparing CC_i values.

Entropy Method

Entropy is a term in information theory, also known as the average amount of information [14]. The criteria weights of TOPSIS method are calculated by the Entropy Method. Entropy method is highly reliable and can be easily adopted in information measurement [15]. The calculation steps of Entropy Method are as follows:

Step 1. Calculation of the entropy value for each criterion

In decision matrix D, feature weight pij is of the *i*th alternatives to the *j*th criterion is calculated by

$$p_{ij} = \frac{x_j}{\sum_{i=1}^{m} x_j} \quad i = 1,\ldots,m;\ j = 1,\ldots,n. \qquad [9]$$

,

The output entropy ej of the *j*th criterion becomes

$$e_j = -K\sum_{i=1}^{m} r_{ij}\ln(r_{ij}) \quad , \quad j = 1,\ldots,n \qquad [10]$$

Where $K = \frac{1}{\ln(m)}$ is a constant that assures $0 \le e_j \le 1$ and

e_i indicates the entropy value with respect to criterion

C_j.

Step 2. Variation coefficient of the *j*th criterion

$$d_j = 1 - e_j, j = 1,\ldots,n \qquad [11]$$

$$w_j = \frac{d_j}{\sum_{j=1}^{n} d_j}, \sum_{i=1}^{n} w_j = 1 \quad j = 1,\ldots,n \qquad [12]$$

whereWjindicates the objective weight for criterionCj.

Analysis and Results

In this paper, we presented a TOPSIS application for Project firm selection in multi criteria environment. In our application four project firms are compared according to criteria: bid, experience, similar work experience, current workload and number of qualified staff as seen on Table 1. The objectives of the survey are to examine the criteria and determine the relative weights of these criteria used by the administration. In determining the weights of the criteria Entropy method is used.

Application of Entropy and TOPSIS Methods in Project Firm Selection

In calculating of weight using entropy analysis, the procedure is as follows; the decision matrix shown in Figure 1. Eq. 1 resulted in the data normalization as shown in Figure 2 while Equations 9, 10, 11 and 12 were applied to obtain the result shown in Table 2.

$$D = \begin{array}{c} \\ A_1 \\ A_2 \\ A_3 \\ A_4 \end{array} \begin{array}{c} \begin{array}{ccccc} C_1 & C_2 & C_3 & C_4 & C_5 \end{array} \\ \begin{bmatrix} 150000 & 1 & 35000 & 12000 & 5 \\ 145000 & 8 & 18000 & 10000 & 4 \\ 160000 & 9 & 21000 & 9000 & 6 \\ 163000 & 12 & 36000 & 11000 & 3 \end{bmatrix} \end{array}$$

Figure 1:Decision matrix of project firm selection

$$R = \begin{bmatrix} 0{,}484896 & 0{,}543251 & 0{,}610568 & 0{,}568216 & 0{,}539164 \\ 0{,}468733 & 0{,}395092 & 0{,}314007 & 0{,}473514 & 0{,}431331 \\ 0{,}517223 & 0{,}444478 & 0{,}366341 & 0{,}426162 & 0{,}646997 \\ 0{,}526921 & 0{,}592638 & 0{,}628013 & 0{,}520865 & 0{,}323498 \end{bmatrix}$$

Figure 2:Normalized decision matrix

According to TOPSIS method's calculations, the results are shown in Table 3. From the result obtained it can be learned that it is feasible to use entropy analysis and TOPSIS to select the best project firm. According to Table 3, because of the highest performance value for Firm A is best Project firm. The results of this study show that the most appropriate Project firm was A. Because the proposed solution can handle the effects of dependences, it is relatively useful and makes the evaluation result to be more reasonable.

CONCLUSION

The objective of this paper is to introduce the application of the TOPSIS in selecting best project firm. This article will briefly review the concepts and applications of the multiple criteria decision analysis, the TOPSIS's implementation steps, and demonstrate TOPSIS application by determining theimportance weights with Entropy on project firm prequalification problem. It is indicated that this application can be used in the whole prequalification.

Table 1.
The dataofthe project company according to the each criteria

	Bid (TL)	Experience (Year)	Similar Work Experience (m^2)	Current Workload (m^2)	Number of Qualified Staff
Firm A	150 000	11	35 000	12 000	5
Firm B	145 000	8	18 000	10 000	4
Firm C	160 000	9	21 000	9 000	6
Firm D	163 000	12	36 000	11 000	3

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Table 2.
Entropy value, the variation coefficient and the entropy of the each criterion

	Bid (TL)	Experience (Year)	Similar Work Experience (m^2)	Current Workload (m^2)	Number of Qualified Staff
e_j	2,230134	2,211693	2,16102	2,222778	2,181365
d_j	-1,23013	-1,21169	-1,16102	-1,22278	-,1,18136
w_j	0,204784	0,201714	0,193278	0,203559	0,196665

Table 3.
d_i^*, d_i^- , values and ranking of alternatives

	d_i^*	d_i^-	C_i	Rank
Firm A	0,069037	0,086711	0,556737	1
Firm B	0,11050	0,040187	0,266691	4
Firm C	0,084917	0,079227	0,48267	3
Firm D	0,086767	0,085309	0,495763	2

REFERENCE

[1] Singh, D., Tiong, R. (2005), 'A fuzzy decision framework for contractor selection', ASCE Journal of Construction Engineering and Management. 131-1. 62-70. | [2] 4734 KamuİhaleKanunu. http:/www1.ihale .gov.tr/mevzuat/. | [3] Fong, P. S. W., Choi, S., K., Y. (2000),'Final contractorselection using the analytical hierarchy process', Construction Management and Economics. 18-5. 547-557. | [4] Sonmez, M., Holt, G., Yang, J., B., Graham, G. (2002),'Applying evidential reasoning to prequalifying construction contractors', ASCE Journal of Management in Engineering. 18-3. 111-119. | [5] Hatush, Z., Skitmore, M. (1997),'Criteria for contractor selection. Construction Management and Economics.15.19–38. | [6] Holt, G., D. (1998), 'Which contractor selection | methodology?', International Journal of Project Management. 16-3. 153–64. | [7] Mahdi, I., M., Riley, M., J., Fereig, S., M., Alex, A., P. (2002),'A multi-criteria approach to contractor selection', Engineering, Construction and Architectural Management. 9(1): 29–37. | [8] Hatush Z., Skitmore, M. (1998), 'Contractor Selection Using Multicriteria Utility Theory: An Additive Model', Building and Environment. 33: 105-115. | [9] Recchia, L., Boncinelli, P., Cini, E., Vieri, M., Pegna, F., Sarri, D. (2011),'Multicriteria analysis and LCA techniques with applications to agro-engineering Products'. Springer. 1-26. | [10]Figueira J., Mousseau V., Roy B. (2005),2,'Multiple criteria decision analysis: State of the art surveys. Springer, New York. | [11] Jahanshahloo, G. R., Hosseinzadeh, L. F., Izadikhah, M. (2006),'Extension of the TOPSIS method for decision making problems with fuzzy data', Applied Mathematics and Computation. 181, 1544-1551. | [12] Jahanshahloo, G., R., Hosseinzadeh, L. F. and Izadikhah M. (2006),'Extension of the TOPSIS Method for Decision - Making Applied Mathematics and Computation'. 181, 2. 1544 – 1551. | [13] Akyene, T. (2012),'Cell Phone Evaluation Base on Entropy and Topsis', Interdisciplinary Journal of Research in Business. 1, 12. 9-15. | [14] Ding, S. and Shi, Z. (2005),'Studies on Incident Pattern Recognition Based on Information Entropy', Journal of Information Science. 31, 6. 497-294. | [15] Zou, Z., Sun, J. and Ren, G. (2005),'Studyand Application on the Entropy Method for Determination of Weight of Evaluating Indicators in Fuzzy Synthetic Evaluation for Water Quality Assessment'. ACTA Scientiae Circumstantiae. 25, 4. 552 – 55. |