World Applied Sciences Journal 24 (4): 540-549, 2013
ISSN 1818-4952

DOI: 10.5829/idosi.wasj.2013.24.04.346

Contractor Selection Based on Swot Analysis with Vikor and Topsis Methods in Fuzzy Environment

[1]*Mohammad Ali Forghani* and [2]*Leyla Izadi*
[1]Department of Management, University of Shahid Bahonar, Kerman, Iran
[2]Department of Industrial Engineering, University of Payame Noor, Hamedan, Iran

Submitted: Feb 8, 2013; **Accepted:** Mar 15, 2013; **Published:** Aug 18, 2013

Abstract: In now competitive world outsourcing is one of important strategies used by modern enterprises. Contractor selection is a multi criteria decision making (MCDM) problem that comprises tangible and intangible factors. Previous contractor selection techniques do not consider strategic perspective. This paper, is applied quantified SWOT in the context of contractor selection under a fuzzy environment, for the first time. In proposed strategic method, strengths weaknesses opportunities threats (SWOT) and their sub-factors are identified in a MCDM hierarchy. By using fuzzy logic and triangular fuzzy numbers, human vagueness in decision making is considered. For evaluating and selecting the best contractor in volunteered contractors, VIKOR method is used. Results are compromised with TOPSIS, well known ranking technique. Proposed method is a quantified strategic method and deal with imprecisely human thought also. Moreover it's interesting for managers for its applied SWOT analysis and applicable for every enterprise with some changes.

Key words: Contractor selection · Fuzzy logic · MCDM · Quantified SWOT Strengths · Weaknesses · Opportunities and Threats · TOPSIS · Triangular fuzzy numbers · VIKOR

INTRODUCTION

During the recent swift progress of network technology and economic globalization, modern industry has been trending towards the increasingly precise division of labor. Consequently, individual enterprises focus on developing their core capabilities and outsource non-core affairs to other partners with different professional capabilities to upgrade their competitive advantage by applying these external and special sources and technology knowledge [1]. Companies try to reduce costs and manage risks. It is important to know that one of the major portions of the firms' expenses is related to logistics activities which mostly are more than 50% of all companies' costs [2, 3]. The overall objective of contractor selection process is to reduce project risk, maximize overall value to the project owner and build the close and long term relationships between members of the project. Contractor selection constitutes a critical decision for project owners. The selection process should embrace investigation of contractors' potential to deliver a service of acceptable standard, on time and within budget [4]. Today's growing numbers of contractor selection methodologies reflect the increasing for improving procurement process and performance [5].

When researchers and practitioners have realized that lowest-price is not the promising approach to attain the overall lowest project cost upon project completion, multi-criteria selection becomes more popular [6, 7].

In the previous research, several authors considered the contractor selection problem. But most of them considered contractor selection in construction industry and other fields are disregarded, whereas many other companies, such as energy generation and distribution companies, face to this problem. More ever, most of previous investigations didn't pay attention to strategic perspective. SWOT (Strengths, Weaknesses, Opportunities and Threats) is a useful technique which is commonly known in strategic management area. SWOT analyzes the external opportunities and threats as well as the internal strengths and weaknesses. Besides, it is one of the most famous tools for strategy formulation. The goal of the analysis of external opportunities and threats is to evaluate whether a

Corresponding Author: Mohammad Ali Forghani, Department of Management, University of Shahid Bahonar, Kerman, Iran. Tel: +09131420034.

company can capture opportunities and avoid threats when facing an uncontrollable external environment such as change in the rule of law [8, 3].

In this paper we used a MADM method to ranking. VIKOR is the useful ranking method considered opposite criteria in decision making. In other way the VIKOR method, a recently introduced new MCDM method developed to solve multiple criteria decision making (MCDM) problems with conflicting and non-commensurable (different units) criteria [9].

In this paper, we use quantified SWOT analysis as a decision tool to formulate strategic plans for contractor selection. To our knowledge, no one has applied SWOT analysis in contractor selection. In this paper, we used the concept of fuzzy set theory and linguistic values to overcome uncertainty and qualitative factors. Then, two hierarchies MCDM model based on fuzzy sets theory and SWOT analysis are proposed to deal with the contractor selection problems. Pairwise comparison used in model, make the obtained weights of criteria are more precise. Fuzzy logic has been integrated with SWOT analysis to deal with vagueness and imprecision of human thought. The model applied in power of electricity distribution company also it's applicable to use in other companies. The proposed decision model is comprehensive and competitive for contractor selection due to its dynamic nature and strategic oriented.

The organization of this paper is as follows: Section 2 discusses the literature review about contractor selection, quantified SWOT and Fuzzy set theory, VIKOR and TOPSIS methods are presented in Section 3. In Section 4, methodology is illustrated. Case study is presented in Section 5. Finally, conclusions are presented in Section 6.

Literature Review

Contractor Selection: Holt *et al*. [10] developed a quantitative model for selecting construction contractors which utilizes the multi-attribute analysis (MAA) technique. Sonmez [11] applied the evidential reasoning (ER) approach (which is capable of processing both quantitative and qualitative measures) as a means of solving the contractor selection problem (CSP). Hatush and Skitmore [12] proposed a systematic multi-criteria decision analysis technique that is described for contractor selection and bid evaluation based on utility theory and which permits different types of contractor capabilities to be evaluated. Chau *et al*. [13] tested how different managers choose maintenance contractors. This in turn led them to focus on the identification of the major selection attributes and the trade-off weightings among attributes during the selection process.

El-Sawalhi [14] suggested a state-of-the-art model for contractor's pre-qualification by using a hybrid model, combining the merits of Analytical Hierarchy Process (AHP), Neural Network (NN) and Genetic Algorithm (GA) in one consolidated model.

Juan [15] proposed a systematic decision support approach to solve housing refurbishment contractor selection problem by using case-based reasoning (CBR) and data envelopment analysis (DEA). Darvish *et al*. [7] showed how the graph theory and matrix methods may be served as a decision analysis tool for contractor selection.

Doloi *et al*. [16] established a hierarchical structural model to understand pre-emptive qualification criteria and their links to contractors' performance on a project, by employing the structural equation modeling technique.

Jaskowski *et al*. [17] suggested the application of an extended fuzzy AHP method to the process of group decision making in contractor selection problem. Watt *et al*. [18] used an experimental design approach to quantify the importance of nine common criteria used in an actual evaluation and selection of a contractor/supplier.

Ng & Tang [19] established a set of Critical Success Factors (CSFs) for construction sub-contractors which are labor-intensive in nature.

Quantified Swot: SWOT (Strengths, Weaknesses, Opportunities and Threats) is one of the most well-known techniques for conducting a strategic study [3]. SWOT analysis is a commonly used tool for analyzing internal and external environments in order to attain a systematic approach and support for a decision situation (e.g. [20, 21]). Kurttila *et al*. [22] presented a hybrid method for improving the usability of SWOT analysis. AHP's connection to SWOT yields analytically determined priorities for the factors included in SWOT analysis and makes them commensurable. Yûksel and Dagdeviren [23] using Analytic Network Process (ANP), demonstrated a process for quantitative SWOT analysis that can be performed when there is dependence among strategic factors.

Chang and Huang [8] presented a Quantified SWOT analytical method which provides more detailed and quantified data for SWOT analysis. The Quantified SWOT analytical method adopts the concept of Multiple-Attribute Decision Making (MADM), which uses a multi-layer scheme to simplify complicated problems and thus is able to perform SWOT analysis on several enterprises simultaneously.

Fuzzy Logic: Fuzzy set theory was introduced by Zadeh [24] in 1965 to solve problems involving the absence of sharply defined criteria. Because fuzziness and vagueness are common characteristics in many decision-making problems, good decision-making models should be able to tolerate vagueness or ambiguity [25]. Thus, if the uncertainty (fuzziness) of human decision-making is not taken into account, the results from the models can be misleading. Fuzzy theory has been applied in a variety of fields since its introduction. Many fuzzy AHP methods are proposed to solve various types of problems [26]. The main theme of these methods, is using the concepts of fuzzy set theory and hierarchical structure analysis to present systematic approaches in selecting or justifying alternatives [27].

Zhu *et al*. [28] proves the basic theory of the triangular fuzzy number and improves the formulation of comparing the triangular fuzzy number's size.

The simple and popular method, centroid method is adopted to defuzzify triangular fuzzy numbers [3, 29]. It should be mentioned that the above methodology is simple and easy to use for practitioners. A defuzzified triangular fuzzy number (n^-, n, n^+), is calculated by Eq. (1).

$$\text{Defuzzified number} = 1/3\,(n^- + n + n^+) \qquad (1)$$

MATERIALS AND METHODS

Vikor Method: The multi-criteria merit for compromise ranking is developed from the Lp-metric used in the compromise programming method [30]. The compromise ranking method (known as VIKOR) is introduced as one applicable technique to implement within the MCDM. Assuming that each alternative is evaluated according to each criterion function, the compromise ranking is performed by comparing the measure of closeness to the ideal alternative [31-33].

The VIKOR method was developed to solve MCDM problems with conflicting and non-commensurable (different units) criteria, assuming that compromising is acceptable for conflict resolution, the decision maker wants a solution that is the closest to the ideal and the alternatives are evaluated according to all established criteria. This method focuses on ranking and selecting from a set of alternatives in the presence of conflicting criteria and on proposing compromise solution (one or more). The VIKOR method is extended with a stability analysis determining the weight stability intervals and with trade-offs analysis. The extended VIKOR method is compared with three multi-criteria decision making methods: TOPSIS, PROMETHEE and ELECTRE [34].

The multiple criteria decision making (MCDM) methods VIKOR and TOPSIS are based on an aggregating function representing ''closeness to the ideal'', which originated in the compromise programming method. In VIKOR linear normalization and in TOPSIS vector normalization is used to eliminate the units of criterion functions. The VIKOR method of compromise ranking determines a compromise solution, providing a maximum ''group utility'' for the ''majority'' and a minimum of an individual regret for the ''opponent''. The TOPSIS method determines a solution with the shortest distance to the ideal solution and the greatest distance from the negative-ideal solution, but it does not consider the relative importance of these distances [33].

Sayadi *et al*. [35] extend the VIKOR method for decision making problems with interval number. The extended VIKOR method's ranking is obtained through comparison of interval numbers and for doing the comparisons between intervals, They introduce á as optimism level of decision maker.

The VIKOR procedure consists of the following steps:

- Determine the best f_i^* and the worst f_i^-

$$f_i^* = \max_i f_{ij},\; f_i^- = \min_i f_{ij}, \qquad (2)$$

if the i-th detailed criteria represents Strengths or Opportunities;

$$f_i^* = \min_i f_{ij},\; f_i^- = \max_i f_{ij}, \qquad (3)$$

if the i-th detailed criteria represents Weaknesses or Threats.

- Compute the values Sj and *Rj*, j = 1,2,. . ., J, by the relations,

$$S_j = \sum_{i=1}^{n} w_i (f_i^* - f_{ij})/(f_i^* - f_i^-), \qquad (4)$$

$$R_j = \max_i [w_i (f_i^* - f_{ij})/(f_i^* - f_i^-)], \qquad (5)$$

where wi are weights of detailed criteria that obtained from DM's preferences.

- Compute the values Q_j, j = 1,2,...,J, by the relation

$$Q_j = v(S_j - S^*)\big/(S^- - S^*) + (1 - v)(R_j - R^*)\big/(R^- - R^*), \qquad (6)$$

where $S^* = \min_j S_j, S^- = \max_j S_j, R^* = \min_j R_j, R^- = \max_j R_j$; and v is introduced as a weight for the strategy of maximum group utility, whereas $1-v$ is the weight of the individual regret.

- Rank the alternatives, sorting by the values S, R and Q in decreasing order.
- Propose as a compromise solution the alternative ($A^{(1)}$) which is the best ranked by the measure Q (minimum) if the following two conditions are satisfied:
  C1. Acceptable advantage:

$Q(A^{(2)})-Q(A^{(1)}) \geq DQ$,

where $A^{(2)}$ is the alternative with second position in the ranking list by Q; $DQ = 1/(J-1)$.
C2. Acceptable stability in decision making:

- The alternative $A^{(1)}$ must also be the best ranked by S or/and R. This compromise solution is stable within a decision making process, which could be the strategy of maximum group utility (when $v>0.5$ is needed), or ''by consensus'' $v \approx 0.5v$, or ''with veto'' ($v < 0.5$). Here, v is the weight of decision making strategy of maximum group utility. Here, v is the weight of decision making strategy of maximum group utility.

If one of the conditions is not satisfied, then a set of compromise solutions is proposed, which consists of

- Alternatives $A^{(1)}$ and $A^{(2)}$ if only the condition C2 is not satisfied, or
- Alternatives $A^{(1)}, A^{(1)},...,A^{(M)}$ if the condition C1 is not satisfied; $A^{(M)}$ is determined by the relation $Q(A^{(M)}) - Q(A^{(1)}) < DQ$ for maximum M (the positions of these alternatives are ''in closeness'') [34].

Topsis Method: TOPSIS (technique for order preference by similarity to an ideal solution) is one of the useful techniques to manage real-world problems [36]. TOPSIS method is presented in Chen & Hwang [37], with reference to Hwang, C.L., Yoon [38]. According to this technique, the best would be the one that is nearest to the positive ideal solution and farthest from the negative ideal solution [39, 40].

The TOPSIS procedure consists of the following steps:

- Calculate the normalized decision matrix. The normalized value r_{ij} is calculated as

$$r_{ij} = f_{ij} \Big/ \sqrt{\sum_{j=1}^{J} f_{ij}^2}, \; j = 1,\ldots,J; i = 1,\ldots,n. \tag{7}$$

- Calculate the weighted normalized decision matrix. The weighted normalized value v_{ij} is calculated as

$$v_{ij} = w_i r_{ij}, j = 1,\ldots,J; i = 1,\ldots,n, \tag{8}$$

where w_i is the weight of the ith attribute or criterion and $\sum_{i=1}^{n} w_i = 1$.

- Determine the ideal and negative-ideal solution.

$$A^* = \{v_1^*,\ldots,v_n^*\} = \{(\max_j v_{ij} | i \in I'),(\min_j v_{ij} | i \in I'')\}, \tag{9}$$

$$A^- = \{v_1^-,\ldots,v_n^-\} = \{(\min_j v_{ij} | i \in I'),(\max_j v_{ij} | i \in I'')\}, \tag{10}$$

where I' is associated with benefit criteria and I'' is associated with cost criteria.

- Calculate the separation measures, using the dimensional Euclidean distance. The separation of each alternative from the ideal solution is given as

$$D_j^* = \sqrt{\sum_{i=1}^{n} (v_{ij} - v_i^*)^2}, \; j = 1,\ldots,J. \tag{11}$$

Similarly, the separation from the negative ideal solution is given as

$$D_j^- = \sqrt{\sum_{i=1}^{n} (v_{ij} - v_i^-)^2}, \; j = 1,\ldots,J. \tag{12}$$

- Calculate the relative closeness to the ideal solution. The relative closeness of the alternative a_j with respect to A^* is defined as

$$C = D \big/ (D_j^* + D_j^-), \; j = 1,\ldots,J. \tag{13}$$

- Rank the preference order [33].

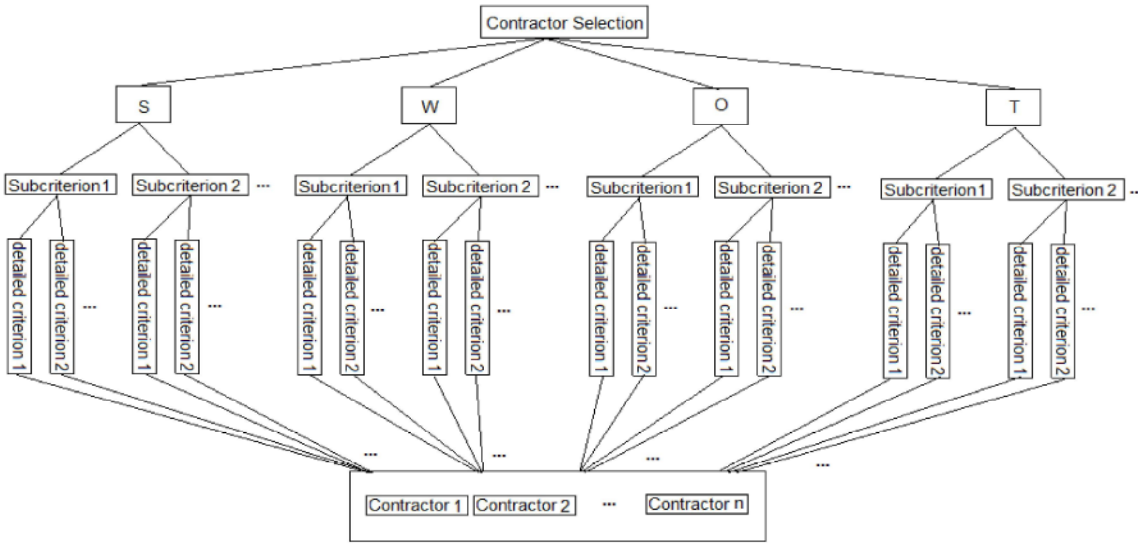

Fig. 1: SWOT hierarchy

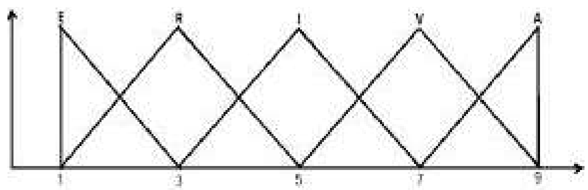

Fig. 2: Linguistic scale for pairwise comparison

Table I: Characteristic function of the fuzzy numbers

Fuzzy number	Membership function
$\tilde{x}$	(x-2, x, x+2)
$\frac{1}{\tilde{1}}$	$(3^{-1},1^{-1},1^{-1})$
$\frac{1}{\tilde{x}}$	$((X+2)^{-1}, x^{-1},(x-2)^{-1})$
$\frac{1}{\tilde{9}}$	$(\tilde{9},\tilde{9},7^{\lceil 1})$

Methodology: A systematic fuzzy model for contractor selection is proposed in this section. The steps are summarized as follows:

Step 1. Form the committee of experts: in the first step it's necessary to form a committee of experts in contractor selection in the company and define the problem and model.

Step 2. Model a SWOT hierarchy Model a SWOT hierarchy: model a hierarchy with contractor selection as goal in first level, SWOT merits are in second level; form sub-criteria for each merit in third level and lowest level contains the alternatives (contractors) that are under evaluation. SWOT hierarchy is sown in Fig. 1.

Step 3. Publish an advertisement: The members of committee decide publish an advertisement in newspaper to identify the tier suppliers who are interested to contribute in the project. The team announce requirements such as financial ability, ...

Step 4. Determine the priorities of SWOT and sub-criteria in problem: Formulate the questionnaire and give to experts to fill them. This step is very important and time consumer. When the number of candidates and criteria grows, the pairwise comparison process becomes cumbersome and the risk of generating inconsistencies grows. In addition, AHP, like as many systems which work based on pairwise comparisons, can produce ‘‘rank reversal” results [41]. Then in this study we didn't use pair wise comparison between criteria in MCDM hierarchy.

Step 5. Determine the importance of SWOT, sub-criteria and detailed criterion, with respect to upper level, using linguistic variables. Linguistic variables set is consist of "equal important (E), rather important (R), important (I), very important (V) and absolutely important (A) ". These linguistic variables are quantified as fuzzy numbers shown in Fig. 2.

Fuzzy relations and membership function in this section are shown in Table I:

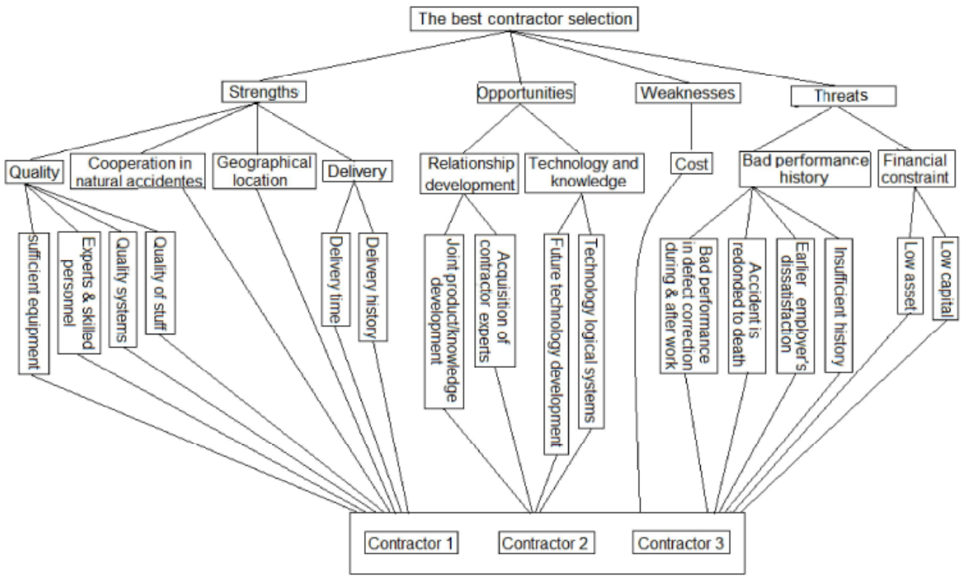

Fig. 3: SWOT hierarchy for Electric Company

Step 6. Calculate crisp relative weights for SWOT merits and sub-criteria: Calculate crisp relative importance weights of SWOT merits and sub-criteria and detailed criteria from expert's opinions. (l_t, m_t, u_t) is the fuzzy importance weight form expert t. A triangular fuzzy number is obtained by aggregating the expert's options. Then defuzz obtained number for each of SWOT factors and sub-criteria by centroid method Eq. (1).

Step 7. Model a questionnaire and determine scores of contractors: formulate a questionnaire based on Fig. 1 to consider preferences and scores of the contractors with respect to detailed criteria and give to experts to fill them. Using the linguistic variables that shown in Fig. 2.

Step 8. Calculate crisp score relative contractors: This step is performed by using similar procedure in step 5.

Step 9. Use VIKOR to select the best contractor: select the best contractor using VIKOR method mentioned in **S**ection 3.1.

Step 10. Use TOPSIS to select the best contractor: select the best contractor using TOPSIS method mentioned in **S**ection 3.2.

Step 11. Compare the results of VIKOR and TOPIS methods.

Case Study: A case study is presented in this section to demonstrate the practicality of proposed model. The model examined in Electricity Company of South Kerman.

A committee including three experts from engineering and commercial departments in Electric Company is formed. The research scope is in transition lines constructors in Iran.

With review of literature, consultation with experts and consideration of documents, SWOT hierarchy (Fig. 3) is organized.

An advertisement is published in newspaper to identify the tier contractors who are interested to contribute in the project and requirement is announced.

The questionnaires are prepared and targeted on experts to fill. Fuzzy importance relative for main criteria is established based on the pairwise comparison results. For example, the pairwise comparison results between quality and sufficient delivery are (3,5,7), (1,3,5), (5,7,9). The experts opinions are as below:

$$n^{\ulcorner} \copyright (3\lambda 1\lambda 5)^{\frac{1}{3}} \copyright 2.466$$

$$n \copyright (5\lambda 3\lambda 7)^{\frac{1}{3}} \copyright 4.718$$

$$n^{\lrcorner} \copyright (7\lambda 5\lambda 9)^{\frac{1}{3}} \copyright 6.805$$

Crisp weights of SWOT, sub-criteria and detailed criteria are obtained by using Eq. (1), results are shown in TABLE II.

Score of every detailed criteria is provided by decision makers. Average of decision makers' opinions is the score of detailed criteria which is a

Table II: Relative priorities of criteria (S,W, O, T), Sub-criteria, Detailed criteria

no	Factors	Sub-criteria	Local weights	Detailed criteria	Local weights	Final priorities
1	Strengths(0.269)	Quality	0.368	Quality of stuff	0.616	0.061
2				Quality systems	0	0
3				Experts& skilled personnel	0.232	0.023
4				Sufficient equipment	0.152	0.015
5		Delivery	0.275	Delivery time	0.5	0.037
6				Delivery history	0.5	0.037
7		Geographical location	0.09			0.024
8		Cooperation in natural accidents	0.267			0.072
9	Weaknesses (0.256)	Cost				0.256
10	Opportunities (0.221)	Relationship development	0.752	Joint product/knowledge development	0.823	0.137
11				Acquisition of contractor's experts	0.177	0.029
12		Technology and knowledge	0.248	Technological systems	0.855	0.047
13				Future technology development	0.145	0.008
14	Threats (0.253)	Financial constraint	0.587	Low capital	0.734	0.11
15				Low asset	0.266	0.04
16		Bad performance history	0.414	Earlier employer's dissatisfaction	0.312	0.033
17				Accident is redounded to death	0.365	0.038
18				Insufficient history	0.169	0.018
19				Bad performance in defect correction during& after work	0.154	0.016

Table III: Scores of each contractor in detailed criteria f_i^* f_i^- and, A^*, A^- values

	Contractor 1		Contractor 2		Contractor 3					
Detailed criteria	Fuzzy number	Crisp value	Fuzzy number	Crisp value	Fuzzy number	Crisp value	f_i^*	f_i^-	A^*	A^-
1	(1.5,3,5)	3.17	(2,4,6)	4	(4,6,8)	6	6	3.17	0.017	0.008
2	(0.33,1,2.33)	1.22	(2.33,4.33,6.33)	4.33	(2,3.67,5.67)	3.78	4.33	1.22	0	0
3	(3,5,7)	5	(4.33,6.33,8.33)	6.33	(5.67,7.67,9)	7.44	7.44	5	0.008	0.005
4	(6.33,7.67,9.33)	7.78	(5.67, 7.67,9.33)	7.56	(5,7,8.67)	6.89	7.78	6.89	0.005	0.005
5	(4.33,6.33,8.33)	6.33	(4.33, 6.33,8.33)	6.33	(7,8.67,9.67)	8.44	8.44	6.33	0.014	0.010
6	(5,7,8.67)	6.89	(7,9,10)	8.67	(5,7,8.67)	6.89	8.67	6.89	0.013	0.011
7	(7,8.67,9.67)	8.44	(3,5,7)	5	(2.67,4.33,6.33)	4.44	8.44	4.44	0.009	0.005
8	(5,7,8.67)	6.89	(1.33,3,5)	3.11	(3,5,7)	5	6.89	3.11	0.021	0.016
9	(3,5,7)	6.89	(2.33,4.33,6.33)	4.33	(3,5,7)	5	4.33	6.89	0.045	0.074
10	(3.67,5.67,7.33)	5.56	(3,5,7)	5	(5.67,6.67,9.33)	7.56	7.56	5	0.047	0.032
11	(3.67,5.67,7.33)	5.56	(3.67,5.67,7.67)	5.67	(5.67,7.67,9.33)	7.56	7.56	5.56	0.010	0.007
12	(3,5,7)	5	(3.67,5.67,7.67)	5.67	(3.67,5.67,7.67)	5.67	5.67	5	0.012	0.010
13	(3.67,5.67,7.67)	5.67	(4.33,6.33,8.33)	6.33	(5.67,7.67,9.33)	7.56	7.56	5.67	0.003	0.002
14	(2.33,4.33,6.33)	4.33	(1.33,3,5)	3.11	(2,3.67,5.67)	3.78	3.11	4.33	0.014	0.020
15	(3,5,7)	5	(1.67,3.67,5.67)	3.67	(2,3.67,5.67)	3.78	3.67	5	0.006	0.008
16	(2.33,4.33,6.33)	4.33	(1,3,5)	3	(1.33,3,5)	3.11	3	4.33	0.004	0.006
17	(2.67,4.33,6.33)	4.44	(0,0.67,2.33)	1	(0,0.33,1.67)	0.67	0.67	4.44	0.001	0.007
18	(1.33,2.67,4.33)	2.78	(1,3,5)	3	(0.67,2.33,4.33)	2.44	2.44	3	0.002	0.002
19	(0.33,1.67,3.67)	1.89	(1.33,3,5)	3.11	(0.67,2.33,4.33)	2.44	1.89	3.11	0.001	0.002

Table IV: Results obtained VIKOR and TOPSIS

		Altenatives			
		Contractor 1	Contractor 2	Contractor 3	Ranking
VIKOR	S	0.837	0.394	0.253	3,2,1
	R	0.256	0.137	0.067	3,2,1
	Q	1	0.306	0	3,2,1
TOPSIS	D^*	0.036	0.015	0.006	3,2,1
	D^-	0.006	0.025	0.034	3,2,1
	C^*	0.141	0.626	0.858	3,2,1

triangular fuzzy number, these fuzzy numbers are defuzzed by Eq. (1) and crisp score for each contractor is obtained.

Values of f_i^*, f_i^- for each contractor in detailed criteria are calculated and shown in Table III.

Finally contractors is ranked by VIKOR. The values of S, R, Q are calculated for all contractors from Eq. (4)- (6) as shown in TABLE IV. The ranking of the contractors by S, R, Q in increasing order is shown in TABLE IV. As we see in Table, the contractor 3 is the best ranked by S, R, Q. So contractor 3 is the best choice.

Moreover values of A^* and A^- for each detailed criteria are obtained from Eq. (9), (10). Results are shown in TABLE III. Then D^-, C^* and D^* are calculated from Eq. (11)- (13). The ranking of the contractors by D^-, C^* in decreasing order and by D^* in increasing order is shown in TABLE IV. As we see in Table, the contractor 3 is the best ranked by D^-, C^* and C^*. So contractor3 is the best choice.

As it can be seen in TABLE IV, contractor ranking is 3, 2, 1 and contractor 3 is the best contractor in both methods. Obtained results show that two methods construct the same ranking, with their differences in utility function. Contractor 3 has external opportunities for development and potentially has internal competing strength to get the opportunities. Therefore, it can be concluded that this contractor is in the best position for facing competition. Contractor 2 (in the third quadrant) has low competitive strength and facing threats from other competitors.

CONCLUSION

During the recent swift progress of network technology and economic globalization, modern industry has been trending towards the increasingly precise division of labor. Consequently, individual enterprises focus on developing their core capabilities and outsource non-core affairs to other partners with different professional capabilities. Companies try to reduce costs and manage risks. It is important to know that one of the major portions of the firms' expenses is related to logistics activities which mostly are more than 50% of all companies' costs. The overall objective of contractor selection process is to reduce project risk, maximize overall value to the project owner and build the close and long term relationships between members of the project.

The aim of this paper is to propose a model based on quantified SWOT in fuzzy environment to solve contractor selection problem. In proposed strategic method, a strengths, weaknesses, opportunities, threats (SWOT) hierarchy is established. Weights of attributes and score matrix obtained from decision makers' opinion, which are in linguistic variable form. With aggregation decision makers' opinion, fuzzy decision matrix is obtained. Then the contractors ranking is done by two useful ranking methods, VIKOR and TOPSIS, then results are compared.

A case study (in Electricity Company of South region of Kerman) is presented to demonstrate the practicality of proposed model. Proposed method is a quantified strategic method and deal with imprecisely human thought also. Moreover it's interesting for managers for its applied SWOT analysis. This model is applicable for every enterprise with some changes.

ACKNOWLEDGMENT

The researchers wish to express their gratitude to the Electricity Distribution Company of South region of Kerman for their informational supports.

REFERENCES

1. Chen, Y.J., 2011. Structured methodology for supplier selection and evaluation in a supply chain. Information Sciences, Article in press.
2. Aissaoui, N., M. Haouari and E. Hassini, 2007. Supplier selection and order lot sizing modeling: A review. Computers & Operations Research, 34(12): 3516-3540.
3. Hassanzadeh Amin, S., J. Razmi and G. Zhang, 2011. Supplier selection and order allocation based on fuzzy SWOT analysis and fuzzy linear programming. Expert Systems with Applications, 38: 334-342.
4. Topcu, Y.I., 2004. A decision model proposal for construction contractor selection in Turkey. Building and Environment, 39: 469-81.
5. Wong, C.H., J. Nicholas and G.D. Holt, 2003. Using multivariate techniques for developing contractor classification models. Engineering, Construction and Architectural Management, 10(2): 99-116.
6. Cheng, E.W.L. and H. Li, 2004. Contractor selection using the analytic network process. Construction Management and Economics, 22: 1021-32.
7. Darvish, M., M. Yasaei and A. Saeedi, 2009. Application of the graph theory and matrix methods to contractor ranking. International Journal of Project Management, 27: 610-619.

8. Chang, H.H. and W.C. Huang, 2006. Application of a quantification SWOT analytical method. Mathematical and Computer Modeling, 43(1-2): 158-169.
9. Opricovic, S. and G.H. Tzeng, 2007. Extended VIKOR method in comparison with outranking methods. European Journal of Operational Research, 178(2): 514-529.
10. Holt, G.D., P.O. Olomolaiye and F.C. Harris, 1994. Evaluating Prequalification Criteria In Contractor Selection. Building and Environment, 29(4): 437-448.
11. Sonmez, M., J.B. Yang and G.D. Holt, 2001. Addressing the contractor selection problem using an evidential reasoning approach. Engineering, Construction and Architectural Management, 8(3): 198-210.
12. Hatush, Z. and M. Skitmore, 1998. Contractor Selection Using Multicriteria Utility Theory: An Additive Model. Building and Environment, 33(2-3): 105-l15.
13. Chau, C.K., W.L. Sing and T.M. Leung, 2003. An analysis on the HVAC maintenance contractors selection process. Building and Environment, 38: 583-591.
14. El-Sawalhi, N., D. Eaton and R. Rustom, 2007. Contractor pre-qualification model: State-of-the-art. International Journal of Project Management, 25: 465-474.
15. Juan, Y.K., 2009. A hybrid approach using data envelopment analysis and case-based reasoning for housing refurbishment contractors selection and performance improvement. Expert Systems with Applications, 36: 5702-5710.
16. Doloi, H., K.C. Iyer and A. Sawhney, 2010. Structural equation model for assessing impacts of contractor's performance on project success. International Journal of Project Management.
17. Jaskowski, P., S. Biruk and R. Bucon, 2010. Assessing contractor selection criteria weights with fuzzy AHP method application in group decision environment. Automation in Construction, 19: 120-126.
18. Watt, D.J., B. Kayis and K. Willey, 2010. The relative importance of tender evaluation and contractor selection criteria, International Journal of Project Management, 28: 51-60.
19. Ng, S.T. and Z. Tang, 2010. Labour-intensive construction sub-contractors: Their critical success factors. International Journal of Project Management, 28: 732-740.
20. Kotler, P., 1988. Marketing Management: Analysis, Planning, Implementation and Control, 6th edn, Prentice-Hall International Edition.
21. Wheelen, T.L. and J.D. Hunger, 1995. Strategic Management and Business Policy, 5th edn. Addison Wesley, Reading, MA.
22. Kurttila, M., M. Pesonen, J. Kangas and M. Kajanus, 2000. Utilizing the analytic hierarchy process (AHP) in SWOT analysis - a hybrid method and its application to a forest- certification case. Forest Policy and Economics, 1: 41-52.
23. Yuksel, I. and M. Dagdeviren, 2007. Using the analytic network process (ANP) in a SWOT analysis - A case study for a textile firm. Information Sciences, 177(16): 3364-3382.
24. Zadeh, L.A., 1965. Fuzzy sets. Information and Control, 8: 338-353.
25. Yu, C.S., 2002. A GP-AHP method for solving group decision-makingfuzzy AHP problems. Computers and Operations Research, 29: 1969-2001.
26. Lee, A.H.I., 2009. A fuzzy supplier selection model with the consideration of benefits, opportunities, costs and risks. Expert Systems with Applications, 36: 2879-2893.
27. Bozbura, F.T., A. Beskese and C. Kahraman, 2007. Prioritization ofhuman capital measurement indicators using fuzzy AHP. ExpertSystems with Applications, 32: 1110-1112.
28. Zhu, K.J., Y. Jing and D.Y. Chang, 1999. A discussion on Extent Analysis Method and application of fuzzy AHP. European Journal of Operational Research, 116: 450-456.
29. Chou, S.Y. and Y.H. Chang, 2008. A decision support system for supplier selection based on a strategy-aligned fuzzy SMART approach. Expert Systems with Applications, 34(4): 2241-2253.
30. Zeleny, M., 1982. Multiple Criteria Decision Making. McGraw-Hill, New York.
31. Opricovic, S., 1998. Multi-criteria optimization of civil engineering systems. Belgrade: Faculty of Civil Engineering.
32. Opricovic, S. and G.H. Tzeng, 2002. Multicriteria planning of post-earthquake sustainable reconstruction. Computer-Aided Civil and Infrastructure Engineering, 17(3): 211-220.
33. Opricovic, S. and G.H. Tzeng, 2004. Compromise solution by MCDM methods: A comparative analysis of VIKOR and TOPSIS. European Journal of Operational Research, 156: 445-455.

34. Opricovic, S. and G.H. Tzeng, 2007. Extended VIKOR method in comparison with outranking methods. European Journal of Operational Research, 178(2): 514-529.
35. Sayadi, M.K., M. Heydari and K. Shahanaghi, 2009. Extension of VIKOR methodfor decision making problemwith interval numbers. Applied Mathematical Modelling, 33: 2257-2262.
36. Yoon, K. and C.L. Hwang, 1985. Manufacturing plant location analysis by multiple attribute decision making: part II. Multi-plant strategy and plant relocation. Int. J. Prod. Res., 23(2): 361-70.
37. Chen, S.J. and C.L. Hwang, 1992. Fuzzy Multiple Attribute Decision Making: Methods and Applications. Springer-Verlag, Berlin.
38. Hwang, C.L. and K. Yoon, 1981. Multiple Attribute Decision Making. Lecture Notes in Economics and Mathematical Systems, vol. 186. Springer-Verlag, Berlin.
39. Benitez, J.M., J.C. Martin and C. Roman, 2004. Using fuzzy number for measuring quality of service in the hotel industry. Tourism Manage. 28(2): 544-55.
40. Zheng Y. Jing, H. Huang and Y. Gao, 2010. Application of improved grey relational projection method to evaluate sustainable building envelope performance. Applied Energy, 87: 710-720.
41. Dyer, J.S., 1990. Remarks on the analytic hierarchy process. Management Science, 36(3): 249-258.