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Supplier Selection Based on Fuzzy Rough-AHP and VIKOR

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Abstract

Supplier selection is one of the most important activities for a company. It significantly reduces the costs and improves the competitiveness of a firm. Supplier selection is a multiple-criteria decision-making (MCDM) problem.To solve this problem, many methods have been introduced in the literature. In this paper, a conceptual framework is proposed in order to select the best supplier considering several criteria. The framework combines the weights obtained from analytical hierarchy process improved by fuzzy rough sets and those obtained from the classical AHP.Then, the VIKOR method is used for ranking the different suppliers.

Keywords: Fuzzy Rough Sets, AHP, VIKOR, Multi-criteria decision making, Supplier selection

Bulanık-Kaba Küme yardımlı AHS ve VIKOR ile Tedarikçi Seçimi

Özet

Tedarikçi seçimi bir şirket için en önemli faaliyetlerden birini oluşturmaktadır. Doğru tedarikçinin seçimi şirketin maliyetlerini önemli ölçüde azaltmakta ve şirketin rekabet gücünü arttırmaktadır. Tedarikçi seçimi bir “çok kriterli karar verme” problemidir. Literatürde bu problemi çözmek amacıyla bir çok metot önerilmiştir. Makalede, çeşitli kriterler dikkate alınarak kavramsal bir model önerisi yapılmaktadır. Model, bulanık kaba kümeler ile geliştirilmiş Analitik hiyerarşi sürecinden (AHS) elde edilen ağırlıklarla, klasik AHS’den elde edilen ağırlıkları birleştirmektedir. Müteakiben tedarikçileri sıralamak için VIKOR yöntemi kullanılmıştır.

AnahtarKelimeler: Bulanık kaba kümeler, AHS, VIKOR, Çok kriterli karar verme, Tedarikçi seçimi

1. Introduction

In today’s competitive operating environment, it is impossible to successfully-produce low cost, high quality products without satisfactory vendors. Thus, one of the most important purchasing decisions is the selection and maintenance of a competent group of suppliers [1]. Selecting the right supplier significantly reduces the material purchasing cost and improves corporate competitiveness, which is why many experts believe that the supplier selection is the most important activity [2]. The objective of supplier selection is to identify suppliers with the highest potential for meeting a firm’s needs consistently and at an acceptable cost. Selection is a broad comparison of suppliers using a common set of criteria and measures. However, the level of detail used for examining potential suppliers may vary depending on a firm’s needs. [3]

Many researchers have spent their efforts on developing supplier selection methodologies. A comprehensive review of supplier selection criteria and methods can be found in [1]. Also, Ho *et al.* [4] studied on a survey about the methods and criteria for supplier selection problem (SSP). According to Ho *et al.* two main methods exist; individual approaches and integrated approaches. Individual approaches include Data Envelopment Analysis (DEA), Mathematical Programming, Analytical Hierarchy Process (AHP), Case-based reasoning, Analytic Network Process, Fuzzy set theory, Simple multi-attribute rating technique and genetic algorithm. Integrated approaches include; integrated AHP approaches, integrated fuzzy approaches, and other approaches.

The AHP, first introduced by Saaty, is one of the most widely adopted MCDM methods. It decomposes a problem into several levels of making up a hierarchy where each decision element is considered to be independent. The distinct strength of method lies in the effective manipulation of quantitative criteria as well as qualitative ones [5]. However classical AHP approach was critized [6] as; (a) The AHP is mainly used in nearly crisp decision applications, (b) Saaty's AHP creates and deals with a very unbalanced scale of estimation, (c) Saaty's AHP does not take into account the uncertainty associated with the mapping of one's perception to a number, (d) Ranking of the AHP is rather not precise, (e) The subjective judgment, selection and preference of decision makers have large influence on AHP.

The Pawlak's rough set concept is a new mathematical approach to imprecision, vagueness and uncertainty. In rough set approach, an arbitrary subset of the universe of discourse can be approximated by two subsets by means of the equivalence classes; namely, lower and upper approximations. Through the lower and upper approximations, one can not only extract the decision rules that are hidden in the database but also select the minimal subset of data that is the most informative [7]. In this context, rough sets are applied to decision analysis, machine learning, knowledge discovery, market research, conflict analysis, and so forth [8]. Rough Set Theory (RST) has been used as such a dataset pre-processor with much success, however it is reliant upon a crisp dataset; important information may be lost as a result of quantization. By using fuzzy-rough sets this loss is avoided, allowing the reduction of noisy, real-valued attributes [9].

Rough set (RS) aided AHP method has been studied by several authors. Jiajang and Wei [10] integrated AHP with rough sets. In their study, the weights of attributes were calculated based on information entropy, then using those weights, the candidate suppliers were ranked. Wang *et al.* [11], combined the objective and subjective judgment matrices by an optimization model. Aydogan [12] studied on a performance measurement application with rough-AHP and FTOPSIS method. Ye and Dong [13] setup a model to assess the commercial bank's capital quality and risk with AHP method and rough set theory. In their paper, they first analyzed the factors related to the quality of capital and then used AHP method to gain the weight of each factor. Minwu *et al.* [14] presented an integrated approach of AHP improved by rough set theory and group decision-making. Then they applied the methodto determine the optimum scheme of high speed railway's exterior power supply. Azadeh *et al* [15] proposed an integrated algorithm using DEA, ANN and RS that assesses the impact of personnel efficiency attributes on total efficiency. Xia and Wu [2] used rough sets for SSP in volume discount environment. They established a rough-AHP method to obtain criteria weights and then they used multi-objective mixed integer programming.

The main objective of this study is to propose a new method for selecting the best supplier considering some criteria. The proposed method consists of 2 steps. First, a new method based on information entropy aided fuzzy rough-AHP is introduced and then suppliers are ranked using the VIKOR algorithm. Those 2 methodologies are used because of several reasons; (a) the reasoning in fuzzy logic is similar to human reasoning. It allows for approximate values and inferences as well as incomplete or ambiguous data (fuzzy data) as opposed to only relying on crisp data (binary yes/no choices). Fuzzy logic is able to process incomplete data and provide approximate solutions to problems other methods find difficult to solve [16]. (b) Rough sets are criticized because of the information loss and crisp nature (c) in order to represent a real world problem, combining experts' opinions and observations (dataset) on suppliers' performance will produce more proper results (d) VIKOR [17] is a helpful tool in multi-criteria decision making, particularly in a situation where the decision maker is not able, or doesn't know to express his/her preference at the beginning of the system design.

The rest of the paper is organized as follows: In the Material and Methods section; Fuzzy rough set aided AHP and VIKOR methods are defined. In Results section; the application of two methods are demonstrated and results are discussed. Conclusion is given in the final section.

2. Materials and Methods

2.1. Information measure for fuzzy-rough set model

The concept of Shannon's entropy [18] is the central role of information theory sometimes referred as measure of uncertainty. The entropy of a random variable is defined in terms of its probability distribution and can be shown to be a good measure of randomness or uncertainty. Shannon's entropy was also used as significance measure in some classical machine learning algorithms.

Definitions 1-6 [19] represent the information measure of fuzzy equivalence relations and show that the entropy can be degraded to Shannon's one when the relation measured is a crisp one.

Definition 1. Given a finite set U, A is fuzzy or real valued attribute set, which generates a fuzzy equivalence relation R on U. The fuzzy equivalence class generated by x_i and $\Re$ is;

$$[x_i]_{\Re} = \frac{r_{i1}}{x_1} + \frac{r_{i2}}{x_2} ... + \frac{r_{in}}{x_n}. \tag{1}$$

Definition 2. The cardinality $[x_i]_{\Re}$ is defined as;

$$\left|[x_i]_{\Re}\right| = \sum_{j=1}^{n} r_{ij} . \tag{2}$$

Definition 3. Information quantity of the fuzzy attribute set or fuzzy equivalence relation is defined as;

$$H(\Re) = -\frac{1}{n}\sum_{i=1}^{n} \log \lambda_i \text{ , where } \lambda_i = \frac{\left|[x_i]_{\Re}\right|}{n}. \tag{3}$$

Definition 4. Given a fuzzy information system $\langle U, A, V, f \rangle$, A is the fuzzy or numeric attribute set. B, E are two subsets of A. $[x_i]_B$ and $[x_i]_E$ are fuzzy equivalence classes containing x_i generated by B and E respectively. The conditional entropy of E conditioned to B is defined as;

$$H(E/B) = -\frac{1}{n}\sum_{i=1}^{n} \log \frac{\left|[x_i]_E \cap [x_i]_B\right|}{\left|[x_i]_B\right|} \tag{4}$$

Clearly, $H(E|B) = H(BE) - H(B)$. (5)

Definition 5. Given a fuzzy information system $\langle U, A, V, f \rangle$, $B \subseteq A, a \in B$, the significance of attribute a in attribute set B is defined as;

$$SIG(a, B) = H(B) - H(B - a) \tag{6}$$

This significance value measures the increment of discernibility power induced by attribute a.

Definition 6. Given a fuzzy information system $\langle U, A, V, f \rangle$, $A = C \cup D$, where C is the condition attribute set and d is the decision attribute. $B \subseteq C$, $\forall a \in B$, the significance of attribute set a in attribute set B relative to d is defined as;

$$SIG(a, B, d) = H(d / B - a) - H(d / B) \tag{7}$$

An Example

Given a set $X = \{x_1, x_2, x_3\}$ and $\Re_1, \Re_2, \Re_3$ are fuzzy equivalence relation on X, induced by attributes a_1, a_2, a_3 as follows;

$$\Re_1 = \begin{bmatrix} 1 & 0.7 & 0 \\ 0.7 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}, \Re_2 = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0.8 \\ 0 & 0.8 & 1 \end{bmatrix} \text{ and } \Re_3 = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0.9 \\ 0 & 0.9 & 1 \end{bmatrix}$$

Then, using Eq(1), we have;

$$[x_1]_{\Re_1} = \frac{1}{x_1} + \frac{0.7}{x_2} + \frac{0}{x_3} = 1.7$$

The entropy of $\Re_1, \Re_2, \Re_3$ are; 1.07460, 1.01963, 0.96762 respectively.

The joint entropy of $\Re_1$ and $\Re_2$; $H(\Re_1 \cap \Re_2)$ =1.58496

Conditional entropy $H(\Re_1 | \Re_2)$ and $H(\Re_2 | \Re_1)$ are;

$H(\Re_1 | \Re_2) = H(\Re_1 \Re_2) - H(\Re_2)$ = 1.58496-1.01963=0.56533

$H(\Re_2 | \Re_1) = H(\Re_1 \Re_2) - H(\Re_1)$ = 1.58496-1.07460=0.51036

Definition 7 [10]. Assuming an information system $\langle U, A, V, f \rangle$ let M_Z denote the combinatorial matrix combining objective matrix M_{obj} and subjective matrix M_{subj}. $M_{obj} = (o_{ij})_{nxn}, (o_{ij}) > 0$, $M_{subj} = (s_{ij})_{nxn}, (s_{ij}) > 0$. So the following optimizing model can be constructed;

$$M_Z = uM_{obj} + (1-u)M_{subj} = u(o_{ij})_{nxn} + (1-u)(s_{ij})_{nxn} \tag{8}$$

"u"should be chosen according to creditability of the objective weights.

2.2. The VIKOR Method

The VIKOR method was developed for multi-criteria optimization of complex systems. It determines the compromise ranking list, the compromise solution and the weight stability intervals for preference stability of the compromise solution obtained with initial (given) weights. This method focuses on ranking and selecting from a set of alternatives in the presence of conflicting criteria. It introduces the multi-criteria ranking index based on the particular measure of "closeness" to "ideal solution"

Assuming that each alternative is evaluated according to each criterion function, the compromise ranking could be performed by comparing the measure of closeness to the ideal alternative. The multi-criteria measure for compromise ranking is developed from the $L_p - metric$ used as an aggregating function in a compromise programming method. The various J alternatives are denoted as $a_1, a_2, ...a_j$. For all alternative a_j, the rating of the i th aspect is denoted by f_{ij}, i.e. f_{ij} is the value of i th criterion function for the alternative a_j; n is the number of criteria.

The compromise ranking algorithm VIKOR has the following steps; the mathematics concept was borrowed from Opricovic and Tzeng [17].

Step 1. Determine the best f_i^* and the worst f_i^- values of all criterion functions, $i = 1,2,...,n$. If the i th function represents a benefit then;

$$f_i^* = \max_j f_{ij} \text{ and } f_i^- = \min_j f_{ij} . \quad (9)$$

Step 2. Compute the values S_j and R_j, $j = 1,2,..., J$, by the relations

$$S_j = \sum_{i=1}^{n} w_i (f_i^* - f_{ij})/(f_i^* - f_i^-) \quad (10)$$

$$R_j = \max_i [w_i (f_i^* - f_{ij})/(f_i^* - f_i^-)] \quad (11)$$

where w_i are the weights of criteria, expressing their relative importance.

Step 3. Compute the values Q_j $j = 1,2,..., J$, by the relation

$$Q_j = v(S_j - S^*)/(S^- - S^*) + (1-v)(R_j - R^*)/(R^- - R^*) \quad (12)$$

Where,

$$S^* = \min_j S_j , S^- = \max_j S_j , \; R^* = \min_j R_j , \; R^- = \max_j R_j , \quad (13)$$

And v is introduced as weight of the strategy of "majority of criteria" (or "the maximum group utility"), here v =0.5.

Step 4. Rank the alternatives sorting by the values S, R and Q, in decreasing order. The results are three ranking lists.

Step 5. Propose as a compromise solution the alternative (a') which is ranked the best by measure Q (minimum) if the following two conditions are satisfied:

C1. "Acceptable advantage": $Q(a'') - Q(a') \geq DQ$, where a'' is the alternative with the second position in the ranking list by Q; $DQ = 1/(J-1)$; J is the number of alternatives.

C2."Acceptable stability in decision making": Alternative (a') must also be the best ranked by S or/and R. This compromise solution is stable within a decision making process, which could be: "voting by majority rule" (when $v > 0.5$ is needed), or "by consensus" $v \approx 0.5$, or "with veto" ($v < 0.5$). Here, v is the weight of the decision making strategy "the majority of criteria" (or "the maximum group utility").

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

Alternatives a' and a'' if only condition C2 is not satisfied, or

Alternatives $a', a'',..., a^{(M)}$ if condition C1 is not satisfied; and $a^{(M)}$ is determined by relation

$Q(a^{(M)}) - Q(a') < DQ$ for the maximum M (the positions of these alternatives are "in closeness").

The best alternative, ranked by Q, is the one with the minimum value of Q. The main ranking result is the compromise ranking list of alternatives, and the compromise solution with the "advantage rate".

3. Proposed Model

The steps of conceptual framework are represented as follows;

Step1. Establish the hierarchical structure of model

Step2. Construct the judgment matrix by means of experts. Check the consistency. Calculate the subjective weights ($M_{Subj} = (s_{ij})_{nxn}$)

Step3. Construct the objective matrix.

Step3.1. Given the performances of suppliers, construct the similarity matrix of criteria.

Step3.2. Calculate the fuzzy-rough information entropy and significance of attributes.

Step3.3. Obtain the objective weights with using significance of attributes ($M_{obj} = (o_{ij})_{nxn}$)

Step 4. Aggregate the objective and subjective matrices via Eq.(8). Obtain the final weight.

Step 5. Use VIKOR algorithm to select the best supplier.

4. An illustrative example

Here, the proposed model will be demonstrated to evaluate different suppliers.

4.1. Establishment of the hierarchical structure of the model

In the supplier/vendor evaluation process, the strategic decision often incorporated critical product- and service-related decision criteria, such as price, delivery performance, and quality [20].

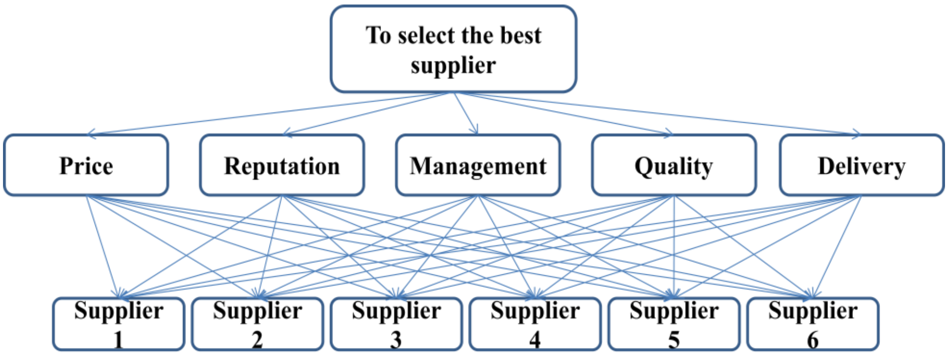

Figure 1. The Decision Hierarchy of SSP

In the first phase, the criteria to be used in ranking and decision hierarchy were determined. Formal AHP model was established such that the goal is in the first level, while criteria and the alternatives are in the second and the third levels respectively. The hierarchical structure of model is shown in figure 1. The chosen criteria are; (C1) *Price*; the total cost of purchasing decision such as inventory carrying, warranty costs, packaging costs, order fulfillment costs and ect. (C2) *Reputation*; the supplier's degree on the distinctiveness, focus, consistency, identity and transparency. (C3) *Management*; the degree of alignment in future plans, management policies, competitive strategies and match between various functions across the supplier organization. (C4) *Quality*; the ability of the each supplier to meet the necessary specifications consistently. (C5) *Delivery*; typical standard lead time after receipt of order currently published to customers by the sales organization.

4.2. Construction of the subjective judgment matrix

In the second step, experts constructed the judgment matrix. Classical AHP is used in order to calculate the weights. The $M_{subj} = (s_{ij})_{nxn}$ matrix, with Maximum Eigen Value =5.37441 and CI=0.0936035, $CR = CI / RI$, $CR = 0.0836 < 0.10$. Then, our judgment matrix is consistent, and there is no need to improve it.

$$\mathrm{M}_{subj}=\begin{bmatrix}1 & 7 & 5 & 1 & 3\\ 1/7 & 1 & 1/3 & 1/7 & 1\\ 1/5 & 3 & 1 & 1/5 & 1/3\\ 1 & 7 & 5 & 1 & 5\\ 1/3 & 1 & 3 & 1/5 & 1\end{bmatrix}$$

Here we obtain the weight vector as [0.352604, 0.0566933, 0.0817448, 0.395008, 0.11395]

4.3. Construction of the objective judgment matrix

The observed fuzzy quantities about suppliers' performance are shown in Table 1. There are 18 different observations about the selected criteria. Also, the crisp decisions are included in dataset. For example, the first row shows the fuzzified value of observed data and corresponding decision respectively. For the decision attribute, "0" means that the supplier is not chosen or vice versa.

Table 1. Fuzzy Decision Table.

Nr.	**C1**	**C2**	**C3**	**C4**	**C5**	**D**	Nr.	**C1**	**C2**	**C3**	**C4**	**C5**	**D**
1	0.47	0.43	0.45	0.21	0.25	0	**10**	0.97	0.52	0.18	0.21	0.45	1
2	0.57	0.45	0.57	0.50	0.55	1	**11**	0.92	0.58	0.23	0.29	0.23	0
3	0.51	0.92	1.00	1.00	0.13	1	**12**	0.97	1.00	0.82	1.00	0.38	1
4	0.00	0.00	0.00	0.29	0.00	0	**13**	0.66	0.06	0.08	0.74	0.20	0
5	0.50	0.66	0.73	0.81	0.15	1	**14**	0.84	0.52	0.65	0.79	0.43	1
6	0.44	0.43	0.53	0.79	0.45	1	**15**	0.72	0.37	0.47	0.89	0.30	1
7	0.60	0.62	0.57	0.00	0.05	0	**16**	1.00	0.12	0.13	0.18	0.53	0
8	0.97	0.52	0.58	0.61	0.65	1	**17**	0.45	0.25	0.28	0.50	1.00	1
9	0.95	0.60	0.67	0.64	0.50	1	**18**	0.23	0.11	0.12	0.71	0.13	0

For constructing the similarity matrix, hamming similarity measure was used;

$$S(x_i,x_j)=\frac{1}{m}\sum_{k=1}^{m}(1-\left|\mu_{A_k}(x_i)-\mu_{A_k}(x_j)\right|) \tag{14}$$

For instance, the distance between 0.47 and 0.57 iscalculated as 0.90. By doing this, a partition on universe using fuzzy equivalence relation is defined. After constructing the similarity matrices, *min* as aggregating operator is used. By using Eq. (7), the significance of the attributes (criteria) are; 0.149315, 0.038395, 0.004003, 0.076768, 0.050302 respectively.

The objective judgment matrix ($\mathrm{M}_{obj}=(o_{ij})_{nxn}$) is constructed by adopting pair-wise comparison method;

$$o_{ij}=\frac{H(D/U-C_i)-H(D/U)}{H(D/U-C_j)-H(D/U)}=\frac{Sig(C_i)}{Sig(C_j)} \tag{15}$$

The objective matrix is calculated as;

$$\mathrm{M}_{Obj} = \begin{bmatrix} 1 & 3.89 & 37.3 & 1.95 & 2.968 \\ 0.26 & 1 & 9.59 & 0.5 & 0.763 \\ 0.03 & 0.1 & 1 & 0.05 & 0.08 \\ 0.51 & 2 & 19.2 & 1 & 1.526 \\ 0.34 & 1.31 & 12.6 & 0.66 & 1 \end{bmatrix}$$

Then matrix is turned into the largest eigenvalue problem and the weights of the criteria are; 0.4684, 0.1204, 0.0126, 0.2408, 0.1578 respectively. The largest eigenvalue of the objective matrix is 5.

From the classical AHP, consistency index;

$$CI = (\lambda_{\max} - n)/(n-1) \tag{16}$$

where n is the rank of judgment matrix. The consistency index CI is “0” which shows that the matrix is completely consistent.

4.4. Aggregation of the objective and subjective matrices

In order to calculate the final weights, combined matrix was constructed by using Eq.(8). Let $u = 0.62$ (the golden section) so there is;

$$\mathrm{M}_Z = 0.62 * \mathrm{M}_{Obj} + 0.38 * \mathrm{M}_{Subj}$$

$$\mathrm{M}_Z = \begin{bmatrix} 0.4272 & 0.41 & 0.4565 & 0.4479 & 0.3794 \\ 0.0913 & 0.0809 & 0.1108 & 0.1029 & 0.1086 \\ 0.0396 & 0.0974 & 0.0182 & 0.0306 & 0.0224 \\ 0.2985 & 0.3153 & 0.2515 & 0.2824 & 0.3623 \\ 0.1434 & 0.0964 & 0.1629 & 0.1362 & 0.1273 \end{bmatrix}$$

By applying sum method we can get the final weights as; [0.424211, 0.098893, 0.041642, 0.302023, 0.133232]

4.5. Application of the VIKOR algorithm

The decision table on suppliers’ performances is shown in Table 2. The weights are taken from fuzzy rough AHP method. Since the criterion C1 cannot be considered as benefit, the best and the worst values of the criterion are interchanged. Further calculations will be based on this assumption.

Table 2. The Decision Table for VIKOR

Criteria	**C1**	**C2**	**C3**	**C4**	**C5**
Weight	0.4242	0.0989	0.0416	0.3020	0.1332
1	253	197	187	90	20
2	268	198	194	130	32
3	330	203	195	145	36
4	327	208	200	150	30
5	329	234	209	200	25
6	281	173	165	163	18
f_i^*	253	234	209	200	36
f_i^-	330	173	165	90	18

5. Results

Table 3 shows the calculations obtained from the VIKOR method using the data in Table 2. The aggregating index values (Q_j) for different weights (0.1, 0.5, 0.9) of decision making strategy (v) are demonstrated below. This shows how the ranks might change when the decision maker uses the maximum group utility under different circumstances. With the application of the VIKOR algorithm (by consensus" $v \approx 0.5$) the second alternative seems to be the best supplier. The numbers in bold letters show the best values for group utility, individual regret and aggregating index. However, the following two conditions shouldbe checked as explained in section 2.2.

Table 3. Calculation of VIKOR method.

Supplier No	S_j **(GroupUtility)**	R_j **(IndividualRegret)**	Q_j **(Aggregatingindex)**		
			v **=0.1**	v **=0.5**	v **=0.9**
1	0,501256	0,302023	0,53987	0,509871	0,479872
2	**0,377001**	0,192196	0,126481	**0,070267**	**0,014053**
3	0,638729	0,424211	0,999499	0,997497	0,995495
4	0,640046	0,407684	0,944898	0,969388	0,993878
5	0,500122	0,418702	0,928439	0,723826	0,519213
6	0,529614	**0,154259**	**0,058018**	0,29009	0,522162

Acceptable advantage;

From the step 5 of VIKOR algorithm; $0.29009 - 0.070267 = 0.219823 \geq 0.2$, so the first condition is satisfied.

Acceptable stability in decision making ;

Second supplier is also the best ranked by corresponding S_j. So, the second condition is satisfied. Then, the second supplier is the best alternative for $v = 0.5$.

The ranks obtained from un-weighted, weighted with AHP, weighted with FR-AHP and weighted with combined approaches are demonstrated in Table 4. According to available data, second supplier is the best choice.

Table 4. Results of VIKOR obtained from different weighting approaches

Methods		Supplier	1	2	3	4	5	6
		Rank						
Un-weighted	v=0.1		5	1	4	2	3	6
	v=0.5		5	1	4	3	2	6
	v=0.9		5	2	3	4	1	6
Weighted with AHP	v=0.1		6	2	5	4	3	1
	v=0.5		5	1	6	4	3	2
	v=0.9		4	1	6	4	2	3
Weighted with FR-AHP	v=0.1		3	1	6	4	5	2
	v=0.5		2	1	6	5	4	3
	v=0.9		2	1	5	6	4	3
Weighted with Combined approach	v=0.1		3	2	6	5	4	1
	v=0.5		3	1	6	5	4	2
	v=0.9		2	1	6	5	3	4

In order to increase the competitive advantage and satisfy the customers' requirements, many companies and enterprises consider the supplier selection problem as an important issue. As a matter of fact, the supplier selection is often influenced by uncertainty and naturally is a complicated multi-objective problem. In this paper, a conceptual framework by means of information entropy based fuzzy rough AHP was proposed. The framework first calculates the weights which are the combination of both the objective and subjective judgment matrices, and then VIKOR algorithm is used for ranking the alternatives. In order to calculate the objective weights, AHP improved by fuzzy-rough sets concept was introduced for the very first time. The FR-AHP method can be used in fuzzy, categorical and continuous valued decision tables where RS-AHP can only be used in categorical valued datasets.

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