RESEARCH ARTICLE OPEN ACCESS

Selection of Supplier by Using Saw and Vikor Methods

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ABSTRACT
Now a days, Lean manufacturing becomes a key strategy for global competition. In this environment the most important process is the efficient selection of suppliers. In any organization various criteria such as quality, cost, location etc are used for the selection of supplier which plays a vital role in the industry. In the present work multi criteria decision making (MCDM) methods are used such as SAW method and VIKOR method. It is used to select the best supplier for implementing the spring manufacturing industry. Choice of the efficient supplier could be a complicated and is a complex problem and this draw back associate degreed a key success for an organization. In this paper linguistic fuzzy data is used to search out the ratings and weights and also the introduced methodologies employed to pick the efficient supplier.
Keywords: lean manufacturing, supplier selection, fuzzy, VIKOR, SAW method.

I. INTRODUCTION

A system consists of organization, group of people and their activities, resources like raw materials, finished goods and information etc. A system which involves in moving a finished product or service from supplier to the customer is called the supply chain. It is a network. It involves the major three following network functions. Most important one is supply of materials to manufacturer, second thing is the manufacturing process and the last one is the distribution of finished goods. Among the three the most important thing is the distribution of finished goods. In this a network of distributors and retailers are used to distribute the finished goods to a final customer. Any organization and its function are marketing, planning, purchasing and finance etc. Each department has shared their information with suppliers and customers. This sharing of information to all the parties enables to plan appropriately for the current and future needs. In general, a product or service of an item there are more number of suppliers are available in the market. Tracing the right supplier is more complex and becomes much more burdensome. Hence, need of best supplier for an organization is a success of the organization. Through successful supply chain, the organization can be achieved numerous goals such as inventory can be minimized, cost can be reduced, delivery time to market can be improved and flexibility can be enhanced. In general, selection of best suppliers may be depends on the several factors.

In any organization the supplier selection process play a vital role and it follows certain aspects. One of the important aspects is identifying a supplier, it is important to gather the information from the stake holder's opinions. The list of stake holders may include members from the departments of purchasing, marketing, quality, finance and research and development and other area related to the organization. During this time, identify the few suppliers based on their capabilities and compare pricing. The selected supplier team can shared their information to all the department members. Another important aspect is measuring supplier performance; another important aspect is developing the audit and assessment program. The purpose of the audit and assessment program me is to understand the suppliers strength and weakness. It can minimize the compliance from the customer and it can improve the quality of the product or service.

In olden day's Manufacturing Company, they have selected supplier based on the price, supplier location and preference. Now day's government and industry have introduced safety and minimum standards and quality on manufacturing company. Hence, in this regard evaluating and selecting the right supplier has become much more critical and complex.

In several manufacturing plants across the world, lean manufacturing techniques are implemented. They have to meet increasing demands and stand up to within the world market. They have expedited them to dramatically increase their competitive edge. Implementing the lean manufacturing techniques reduces the wastes and improves the quality of the product in an organization. Therefore, the product or service is available in the market with low cost. Several companies have enforced lean manufacturing techniques to make a lot of economical work flows. In a lean manufacturing setting the role of supplier selection is significant as a result of they play the role of implementing lean on the processing line.

Several studies have reported for supplier selection based on multi criteria decision making

methods. A case study is conducted in cement manufacturing industry by Rajeswara Reddy et.al. [1] for supplier selection problem. It is chosen several criteria like cost, quality, lead time, and serviceability and payment terms with the recommendation of the decision makers in their departments. The decision makers involved in each departmental heads like material, finance and commercial and operational head. The choice is taken from recommendation of the experts. Based on their recommendation further investigation is carried out through Multi criteria decision making methods such as AHP and TOPSIS to evaluate the best supplier. Murali et.al [2] a case study is conducted in Lanco industry at srikalahasthi for selection of best suppliers by using TOPSIS and PROMETHEE methods. It is conducted assessment program me with each department in the organization for evaluating the best suppliers. It is collected the pool of suppliers selection criteria information from the decision making team. Experts are recommended the selected criteria, based on their opinions further investigation is carried out through multi criteria decision making methods. Finally, from the obtained results and the rank has given to the best suppliers. Parthiban et al. [3] a case study is conducted in automotive component manufacturing industry in southern part of the India. Interpretive structural modeling and AHP methods are used for ranking of the best supplier from the group of the supplier. It is conducted the survey in each department. Data is collected from the company and prepared the data sheet in terms of linguistic variables. Finally, from the obtained results and the rank has given to the efficient suppliers.

In general, successful organization role is improving the quality and reduce the cost and reduce the waste. In addition, raw material procurement and manufacturing process plays a key role in any organization. Procurement of raw material plays in several stages in the organization such as identify, evaluate and contract with supplier. Financial stability of the industry is also depends on the procurement of raw material. Continuous supply of raw material to the firm it effects the financial stability of the firm. Moreover, it takes more time to process. Therefore, selection of lean supplier is critical task for manufacturing industry. With the help of efficient lean supplier, it is possible to improve the quality and reduce the cost of the products. And it is also possible by continuous improvement of the product value or services over a period. And it is also able to meet the demands of the customer.

One of the most important factors is selection of lean supplier. Because it is a complex multi criteria decision making problem to choose among various suppliers. In the present study suppliers is selected by using multi criteria decision making methods such as SAW and VIKOR methods.

Multi-criteria decision-making (MCDM) consigns to screening, prioritizing, ranking, or choosing agroup of choicesunderneath sometimes freelance, unequal or conflicting attributes [4]. Over some years, the Multi-criteria decision-making ways are featured. The ways take issue in several areas theoretical surroundings , type of quarries asked and therefore the type of results known. Some ways are crafted significantly for one specific drawback, and aren't helpful for alternative issues. Alternative ways are additional universal, and lots of them have earned quality in numerous areas. The foremost necessary plan for all the ways is to form a additional formalized and better-informed decision-making method. There are several attainable ways that to classify the present MCDM ways.

Belton and Steward [5] classified them in three broad classes, value measuring model like multi-attribute utility theory (MAUT)and analytical hierarchy method (AHP), outranking models like Elimination and choice Translating Reality (ELECTRE) and Preference Ranking Organization technique for Enrichment analysis (PROMETHEE) and at last, goal aspiration and reference level models like Technique for Order Preference by Similarity to Ideal solution (TOPSIS). The elemental assumption in utility theory is that the choice maker chooses the choice that the expected utility price could be a most [6]. However, it's troublesome in several problems to get a mathematical illustration of the choice maker's utility perform [7]. The analytic hierarchy method (AHP) is wide used for endeavor multi attribute decision-making issues in real things. In spite of its quality and ease in concept, this technique will cause by the choice maker's inability to translate his/her preferences for a few alternatives to another into a completely consistent preference structure.

The VIKOR methodology was developed for multi-criteria optimization of advanced systems [7]. This methodology focuses on ranking and choosing from a collection of alternatives, and determines compromise solutions for a retardant with conflicting criteria, which may facilitate the choice manufacturers to achieve a judgment. Here, the compromise resolution could be a possible resolution that is that the nearest to the perfect, and a compromise means that an agreement established by mutual concessions. It introduces the multi-criteria ranking index supported the actual live of Closeness to the ideal resolution. The VIKOR method uses linear normalization, and the normalized value in the VIKOR method does not depend on the evaluation unit of criterion function.

Simple Additive Weighting (SAW) which is also known as weighted linear combination or scoring methods is a simple and most often used multi attribute decision technique. The method is based on the weighted average. An evaluation score is calculated for each alternative by multiplying the scaled value given to the alternative of that attribute with the weights of relative importance directly assigned by decision maker followed by summing of the products for all criteria. The advantage of this method is that it is a proportional linear transformation of the raw data which means that the relative order of magnitude of the standardized scores remains equal.

In the decision making method, the decision maker is often faced with doubts, issues and doubts. In different words usual language to specific observation or judgment is often subjective, unsure or unclear. To work out the unclearness, ambiguity and judgment of human judgment, fuzzy set theory [8] was introduced to specific the linguistic terms in decision making process (DM). Bellman and Zadesh [9] developed fuzzy multi criteria decision methodology (FMCDM) to resolve the lack of precision in distribution importance weights of criteria and therefore the ratings of alternatives concerning analysis criteria. This logical tool that people can depend on are generally measured the outcome of a bivalent logic (yes/no, true/false), however the issues expose by real-life things and human thought processes and approaches to problem-solving are by number means that bivalent. even as standard, bivalent logic relies on classic sets, formal logic relies on fuzzy sets. A fuzzy set could be a set of objects during which there's no clear-cut or predefined the boundary between the objects that are or don't seem to be members of the set. The key conception behind this definition is that of membership any object could also be a member of a collection to some degree, and a logical proposition may hold true to some degree. Every component during a set is related to a worth indicating to what degree element is a member of the set. This value comes inside the vary (0, 1), wherever zero and one, severally, indicate the minimum and most degree of membership, whereas all the intermediate values indicate degrees of partial membership [10]. This approach helps decision making solve advanced deciding issues during a systematic, consistent and productive approach [11] and has been wide applied to tackle DM issues with multiple criteria and alternatives. In short, fuzzy set theory offers a mathematically precise approach Of modeling obscure preferences asan example once it involves setting the weights of performances scores on criteria.

The five point method proposed by Chen and Hwang [12] first converts linquistic terms into fuzzy numbers and then the fuzzy numbers into crisp scores. The method is described below: This method systematically converts linquistic terms into their corresponding fuzzy numbers. It contains eight conversion scales. To demonstrate the method, a 5-point scale having the linquistic terms low, fairly low, medium, fairly high, and high [12], is considered. These linguistic terms can be equated to other terms like low, below average, average, above average and high.

The linguistic evaluations are converted into fuzzy numbers by using Chan and Hwang Five point scale as specified below.

Table.1.1 Five point conversion Scale

Linguistic term	Fuzzy number	Crisp score
Low	M_1	0.115
Below average	M_2	0.295
Average	M_3	0.495
Above average	M_4	0.695
High	M_5	0.895

II. PROPOSED METHODOLOGY- SAW

A case study is conducted in spring manufacturing unit at Anatapuram. The data is collected for the current industry with the recommendation of decision makers. In the present study three decision makers are from various departments.

In this section a methodical approach of the SAW to solve the supplier selection problem under a fuzzy environment. The magnitude weights of various criteria and the ratings of qualitative criteria measured as linguistic variables. Because linguistic assessments merely about the good judgment of decision makers.

Process of SAW consist of these steps:

Step 1:

1) Construct a pair-wise comparison matrix (n x n) for criteria with respect to objective by using Saaty's 1-9 scale of pair-wise comparisons shown in Table 2.1. In other words, it is used to compare each criterion with each other criterion, one-by-one.

Table2.1. Saaty's [13] 1-9 Scale of Pair-wise comparisons

Scale points	Definition	Explanation
1	Equal Importance	Two activities contribute Equally to the Objective
2	Weak or Slight	
3	Moderate Importance	Experience and judgment slightly favour one activity over another

4	Moderate Plus	
5	Strong Importance	Experience and judgment strongly favour one activity over another
6	Strong Plus	
7	Very Strong	An activity is favored very strongly over another
8	Very, very strong	
9	Extreme Importance	The evidence favoring one activity over another is of the highest possible order of affirmation

2) For each comparison, we will decide which of the two criteria is most important, and then assign a score to show how much more important it is.
3) Compute each element of the comparison matrix by its column total and calculate the priority vector by finding the row averages.
4) Weighted sum matrix is found by multiplying the pair-wise comparison matrix and priority vector.
5) Dividing all the elements of the weighted sum matrix by their respective priority vector element.
6) Compute the average of this value to obtain max
7) Find the consistency Index, CI, as follows:
CI = (λ_{max} –n)/(n-1) (2.1)

Where n is the matrix size.

8) Calculate the consistency ratio, CR, as follows:
CR = CI/RI (2.2)
9) Judgment consistency can be checked by taking the consistency ratio (CR) of CI with the appropriate value in Table 2.2. The CR is acceptable, if it does not exceed 0.10. If it is more, the judgment matrix is inconsistent. To obtain a consistent matrix, judgments should be reviewed and improved.

Table 2.2 Average Random Consistency (RI)

Size of matrix	Random Consistency
1	0
2	0
3	0.58
4	0.9
5	1.12
6	1.24
7	1.32
8	1.41
9	1.45
10	1.49

Step 2: Construct a decision matrix (m x n) that includes m personnel and n criteria. Calculate the normalized decision matrix for positive criteria:
$nij = r_{ij}/r_j^{max}$; i=1,2,3..m;j=1,2,3……n (2.3)

The normalized decision matrix for negative criteria
$n_{ij}=r_j^{min}/r_{ij}$;i=1,2,3……m;j=1,2,3……n.. (2.4)

Where r_j^{max}=maximum number of r in the column of j.

r_j^{min}=minimum number of r in the column of j

Step 3: Evaluate each alternative, A by the following formula:
$Ai = \sum wjx_{ij}$ (2.5)

Where x_{ij} is the score of the i^{th} alternative with respect to the j^{th} criteria, w_j is the weighted criteria.

The way of data collection that is applied for this phase is questionnaire. By using comparison matrix the weights of criteria will be computed. After computing weights of criteria, specifying of consistency rate will be executed. If consistency of data is more than 0.1, revision of pair-wise comparison must be done. So we will continue it until consistency Rate reach to less than 0.1. After CR is less than 0.1, it indicates sufficient consistency. In that time, we use SAW method for ranking personnel. The procedure of methodology has been shown in Fig. 2.1.

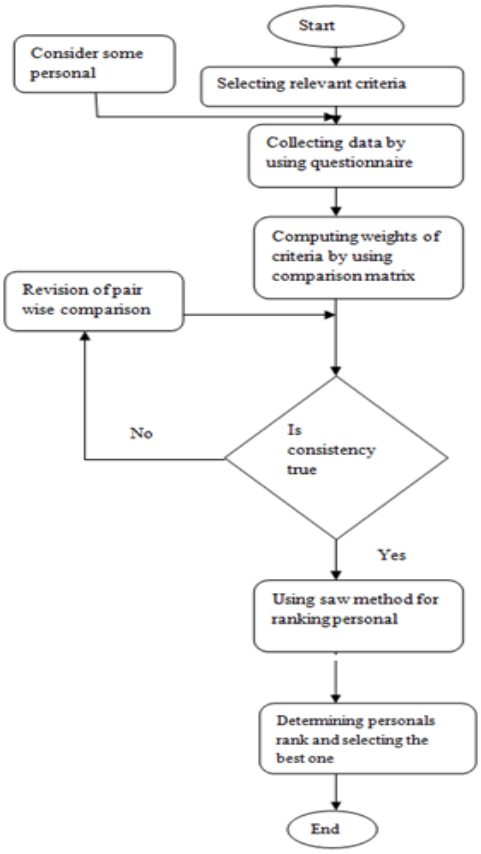


Fig. 2.1. Flow chart of the research frame work

By using the same set of criteria which has chosen for supplier selection using VIKOR method is applied in the present study. And the weights of criteria have been computed by using comparison matrix. The table 2.3 is shown as name of the criteria.

Table 2.3 Criteria's name.

C_1	performance
C_2	Financial position
C_3	Management organization
C_4	Just in time
C_5	Technical capability

The weights of the criteria have been computed by using comparison matrix mean while data was gathered from three experts of the opinion with questioner in one of the spring manufacturing unit by using saaty[11] scale values as shown in the table.2.4

Table 2.4 specifying the scale values of 1-5

Intensity of importance	Definition
1	Equal Importance
2	Moderate Importance
3	Strong Importance
4	Very Strong
5	Extreme Importance

The comparison matrix is shown in table 2.5. it indicating the relative importance of the criterion in the columns compared to the criterion in the rows.

2.1 Test of consistency for selected set of criteria

The consistency Rate calculated was 0.010 that is less than 0.1, indicating sufficient consistency. The following steps will show how the test of consistency will be done.

Step 1: In order to calculate computing Weighted Sum Vector (WSM):

	CI	C2	C3	C4	C5	Weights
C_1	1	1	2	2	2	0.276
C2	1	1	2	2	2	0.276
C3	0.5	0.5	1	1	2	0.16
C4	0.5	0.5	1	1	2	0.16
C5	0.5	0.5	0.5	0.5	1	0.10
Total	3.5	3.5	6.5	6.5	9	1

Table 2.5 Weights of criteria by Comparison matrix.

1	1	2	2	2		0.276	1.392
1	1	2	2	2	X	0.276	= 1.392
0.5	0.5	1	1	2		0.16	0.790
0.5	0.5	1	1	2		0.16	0.790
0.5	0.5	0.5	0.5	1		0.10	0.530

↓

1.392		0.276		5.04
1.392		0.276		5.04
0.790		0.16		4.93
0.790		0.16		4.93
0.530	/	0.10	=	5.30

Table 2.6 computing weighted sum vector

By rounding off the number to three decimal places, we will get Consistency vector (CV). In following division, each corresponding cell must be divided each other.

Table 2.7 consistency vector values (CV)

1.392		0.276		5.04
1.392		0.276		5.04
0.790		0.16		4.93
0.790	/	0.16	=	4.93
0.530		0.10		5.30

Consistency Index (CI) and consistency ratio are calculated using equations 2.1 and 2.2.

$$CI = \underline{5.109-}5/(5-1) = 0.012$$

$\lambda\ max$ =	(5.04 + 5.04 + 4.93 + 4.93 + 5.30)/5=5.048

Consistency rate will be computed as follows as the amount of Random Index (RI) could be got by looking at Table 2.8, according to the value of n (n is size of matrix).

CR = CI/RI = 0.012 /1.12 = 0.010

Table 2.8 Average stochastic uniformity index target value of judgment matrix

n	1	2	3	4	5	6	7	8	9	10
RI	0	0	.85	.9	1.12	1.24	1.32	1.41	1.45	1.51

So the Consistency Index is indicating that the opinion of experts is sufficient. After preparing collected data from experts, based on scale values 1-9 in Table 2.4 and computing weights of criteria in Table 2.5, following steps shows the procedure of SAW method:

Table 2.9 Collected data based on scale values (1-9)

	C_1	C_2	C_3	C_4	C_5
S_1	7	6	6	6	6
S_2	7	7	6	6	7
S_3	6	7	6	5	6
S_4	6	5	7	6	6
S_5	7	6	7	7	6

C means Criteria and S means Supplier

Step 2: In this case study, criteria has been taken as positive and normalized decision matrix for positive criteria are calculated using equations 2.3 The results are as shown in Table 2.11

Table 2.10 Weighted Criteria

C_1	C_2	C_3	C_4	C_5
0.276	0.276	0.16	0.16	0.10

Table 2.11 Normalized decision matrix

	C1	C2	C3	C4	C5
S1	0.276	0.234	0.136	0.136	0.085
S2	0.276	0.276	0.136	0.136	0.10
S3	0.234	0.276	0.136	0.11	0.085
S4	0.234	0.195	0.16	0.136	0.085
S5	0.276	0.234	0.16	0.16	0.085

Step 3: By using the equation 2.5, the simple additive weighting method evaluates each alternative, Ai and is presented in Table2.12

Table 2.12 Weighted Normalized Decision Matrix

	C_1	C_2	C_3	C_4	C_5
S_1	1	0.85	0.16	0.85	0.85
S_2	1	1	0.85	0.85	1
S_3	0.85	1	0.85	0.71	0.85
S_4	0.85	0.71	1	0.85	0.85
S_5	1	0.85	1	1	0.85

Table 2.13 Ranked Personnel

S1	S2	S3	S4	S5.
0.867	0.924	0.840	0.810	0.915

Finally in SAW method, the best supplier is S_2 and then S_3, S_4, S_5 and S_1 will be respectively for the selected first set of criteria. The rating of suppliers using first set of criteria is shown in Fig. 5.1.

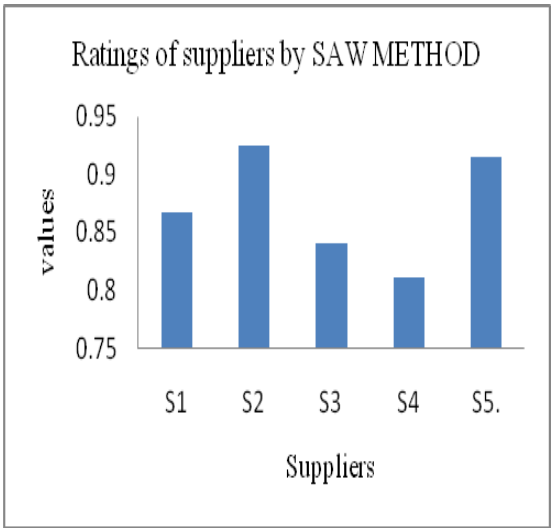


Fig: 2.1 Ratings of suppliers by SAW method

III. PROPOSED METHODOLOGY-VIKOR METHOD

In this section a methodical approach of the VIKOR to solve the supplier selection problem under a fuzzy environment. The magnitude weights of various criteria and the ratings of qualitative criteria measured as linguistic variables. Because linguistic assessments merely about the good judgment of decision makers. Supplier selection in lean manufacturing system first requires the identification of decision attributes (criteria). For this purpose, it is consider as group mulitple criteria decision making problem. This is illustrated the following set of terms.

Among various sets, two sets containing 5 criteria's, C = (C1, C2, C3, C4, C5),S=(S1,S2,S3,S4,S5), and another set containing 3 criteria's DM= (D1,D2,D3).

Where DM- A set of decision makers, S-A Set of possible supplier, C- A set of criteria's.

The main aspects of the work are described; the proposed model has been applied to a lean supplier selection process of a firm working in the field of spring manufacturing unit.

The following steps are

Step1: The company desires to select a good supplier. After preliminary screening, five suppliers (S1,S2,S3,S4,S5), remains further evaluation.

Step 2: Committee of three decision makers (D1,D2,D3) have been formed to select the most suitable supplier. The following first set of criteria have been defined.

Table 3.1 Set of criteria's

C_1	performance
C_2	Financial position
C_3	Management organization
C_4	Just in time
C_5	Technical capability

Step3: Three decision makers use the linguistic weighting variables to asses the importance of the criteria. The importance weights of the criteria determined by these three decision makers are shown in table 3.2. Because to calculate the weights of criteria, it requires the first weight assessments from the experts of decision makers.

Table 3.2 Importance weight of criteria

Criteria	DM_1	DM_2	DM_3
C1	H	H	H
C2	H	H	AA
C_3	AA	A	AA
C4	A	AA	A
C5	A	A	BA

The decision makers is also used the linguistic rating variables to evaluate the ratings of candidates with respect to each criterion. The ratings of the five supplier by the decision makers under the various criteria are illustrated in table 3.3 of each decision makers opinion.

Table 3.3 Rating of suppliers of five suppliers under each criterion in terms of linguistic variables determined by DMs

Criteria	C1			C2			C3				C4		Cs		
Supplier	D_1	D2	D3	D1	D2	D3	D1	D2	D3	D1	D2	D3	D_1	D2	D3
S1	VG	G	F	G	G	F	G	VG	G	G	F	F	G	G	F
S2	G	G	F	VG	G	F	VG	G	F	G	G	G	G	F	F
S3	G	F	F	G	G	F	G	G	F	G	G	F	G	G	F
S4	VG	VG	G	VG	VG	G	VG	VG	G	VG	G	F	VG	G	G
S_5	VG	G	G	G	G	G	VG	VG	VG	VG	G	G	G	G	G

Step 4: The linguistic evaluations shown in Tables 3.2 and 3.3 are converted into fuzzy numbers. Then the aggregated weight of criteria and aggregated fuzzy rating of alternatives is calculated to construct the fuzzy decision matrix and determine the fuzzy weight of each criterion, as shown in Tables 3.4.

Table 3.4 Decision Matrix in Crisp score for suppliers

	C1	C2	C3	C4	C5
Weights	0.267	0.248	0.189	0.168	0.128
S1	0.70	0.63	0.83	0.56	0.63
S_2	0.63	0.70	0.63	0.70	0.56
S_3	0.56	0.63	0.70	0.63	0.63
S_4	0.83	0.83	0.83	0.70	0.76
S5	0.76	0.70	0.90	0.76	0.70

Step 5: The values of S, R and Q are calculated by using the equations, for all the suppliers.

$$Si = \sum_n^m w_j[((m_{ij})max) - (m_{ij})]/ [(m_{ij})max) - (m_{ij})min]$$

$$Ri = Max\ of \sum_n^m w_j[((m_{ij})max) - (m_{ij})]/ [(m_{ij})max) - (m_{ij})min]$$

$$Qi = v((s_i - s_{i\min})/(S_{i\ max} - S_{i\ min})) + (1-v)((R_i - R_{min})/(R_{imax} - R_{imin}))$$

Where S=utility measure, R=Regret measure, Q=Vikor index

Table 3.5 Maximum criterion function of facilitators

C_1	C_2	C_3	C_4	C_5
0.83	0.83	0.90	0.76	0.76

Table 3.6 Minimum criterion function of facilitators

C_1	C_2		C_4	C_5
0.56	0.63	0.63	0.56	0.56

Table 3.7 Utility Measure (s) value of facilitators

S_1	S_2	S_3	S_4	S_5
0.67	0.726	0.84	0.099	0.268

Table 3.8 Regret Measure (R) value of facilitators

S_1	S_2	S_3	S_4	S_5
0.248	0.198	0.267	0.0504	0.161

Table 3.9 VIKOR Index (Q) value of facilitators

S_1	S_2	S_3	S_4	S_5
0.835	0.753	1	0	0.368

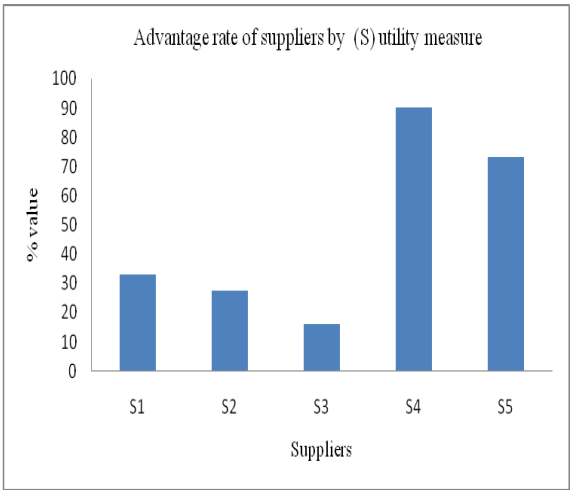
Table 3.10 Ranking of the suppliers by S, R and Q in order

Ranking of Lean Facilitators					
By S	S4	S5	S1	S2	S3
By R	S4	S5	S2	S1	S3
By Q	S4	S5	S2	S1	S3

C_1 : $Q(S_5) - Q(S_4) \geq 1/(m-1)$
$(0.268-0.099) \leq (1/4)$
Condition C_1 is not satisfied.
C_2 : Supplier S_4 has been ranked as best in S and R.
Condition C_2 is satisfied.

The ranking of the lean supplier by S, R and Q in decreasing order is shown in Table 3.11, the compromise solution for the decision for set-1 is the supplier S_4.

The advantage rate of facilitators by S, R and Q are shown in the Figs. 3.1 to 3.3 respectively.



Figs. 3.1 Advantage rate of facilitators by Utility Measure (S)

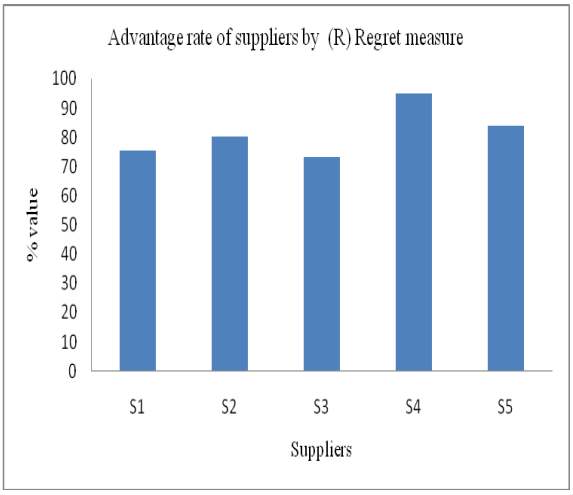


Fig. 3.2. Advantage rate of facilitators by Regret measure (R)

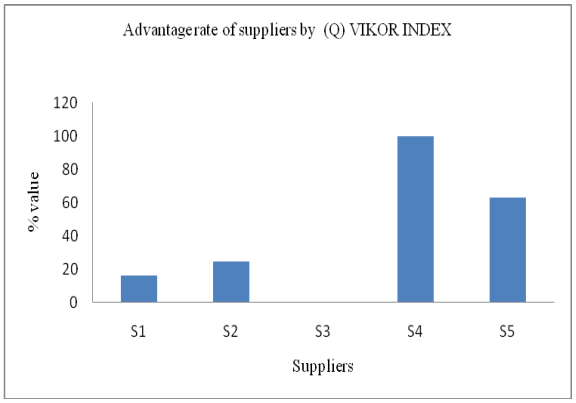


Fig. 3.3. Advantage rate of facilitators by VIKOR INDEX (Q)

IV. CONCLUSIONS

The present study explores the use of SAW method and VIKOR methods in solving a supplier selection problem and the results obtained can be valuable to the decision maker in framing the supplier selection strategies. For the selected criteria, S2, S5, Sl, S3, S4 and S4, S5, S2, S1, S3 are the ranking sequence according to SAW and VIKOR method respectively. The best ranked suppliers S4 have 36.8%, 75.3%, 83.5%, 100% advantage rate over the alternatives S_5

S_2, S_1, S_3 as shown in figure 3.3. Thus, these popular MCDM methods can be successfully employed by the decision makers for the process of supplier selection in the spring manufacturing domain.

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