APPLICATION OF TOPSIS METHOD FOR SUPPLIER SELECTION IN MANUFACTURING INDUSTRY

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ABSTRACT

A supply chain consists of all parties involved directly or indirectly in fulfilling a customer demand. The supply chain department deals with the supplier and their supplies. The aim of this paper is developing a methodology for suppliers in supply chain cycle in a manufacturing industry. This paper has developed for selection of supplier by using Topsis Method**.** For supplier selection different important criteria are taking into account. These criteria have different weightage by different expert. On this basis of this weightage provide the rank of every supplier with the help of Topsis Method.

Keywords: *Supply Chain, Weightage Criteria, Manufacturing industry, Topsis Method.*

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INTRODUCTION

The supply chain includes not only the manufacture and supplier but also transporter, warehouses, retailer and even customers themselves. Supply chain management encompasses both physical distribution and supply management. Increases and varieties of customer demands, advances of recent technologies in communication and information systems, competition in global environment, decreases in governmental regulations, and increases in environmental consciousness have forced companies to focus on supply chain management [7]. "The supply chain management" term has been used for almost 22 years and is defined as the integration of activities to procure materials, transforms them into intermediate goods and final products, and delivers to customers [8]. In supply chains, coordination between a manufacturer and suppliers is typically a difficult and important link in the channel of distribution.

Supply chain management and its demands on the firms in the value chain have led to the operational integration of suppliers within the supply chain [2]. Selecting an appropriate supplier (or vendor) among different suppliers is a critical issue for top management. In industries that are concerned with large scale production the raw materials and components parts van equal up to 70% product cost in such circumstances the purchasing department can play a key role in cost reduction, and supplier selection is one of the most important functions of purchasing management [3]. Therefore, using an appropriate method for this purpose is a critical issue; supplier selection has been shown to be multiple criteria decision making (MCDM) problem [4]. The technique for order preference by similarity to Ideal Solution (TOPSIS) was first developed by Yoon and Hwang In supply chains; Co-ordination between a manufacturer and suppliers is typically a difficult and important link in the channel of distribution. Once a supplier becomes part of a well-managed and established supply chain, this relationship will have a lasting effect on the competitiveness of the entire supply chain. Because of this, supplier problem has become one of the most important issues for establishing an effective supply chain system. Besides, selection of suppliers is a complicated process by the facts that numerous criteria must be considered in the decision making process [5].

The nature of this decision is usually complex and unstructured. On the other hand, supplier selection decision-making problem involves trade of the among multiple criteria that involve both quantitative and qualitative factors, which may also be conflicting. In this paper, with the help of going over expertise of experts and their relevant specialized literature, we can

recognize variables and effective criteria in supplier selection, with regards to this point that, considering all criteria has been extracted by expert judgment. Thereafter, we will evaluate and determine weight of each supplier and finally, by implementing (TOPSIS) method, the rank of each supplier is determined. TOPSIS has been a favorable technique for solving multi criteria problems. This is mainly for two reasons, 1.) Its concept is reasonable and easy to understand. And 2.) In comparison with other MCDM methods, like AHP, it requires less computational efforts, and therefore can be applied easily. TOPSIS is based on the concept that the optimal alternative should have the shortest distance from the positive ideal solution (PIS) and the farthest distance from the negative ideal solution (NIS). TOPSIS method are powerful decision making processes which help people to set priorities on parameters that are to be considered by reducing complex decision to a series of one to one comparisons, thereby synthesizing the result[1].

PROPOSED METHODOLOGY

This methodology for supplier selection using Topsis Method consists of Three Step:-

1. Identify the criteria to be used in the model;
2. By using expert views weighing the criteria;
3. Evaluation of alternatives with TOPSIS and determination of the final mark.

In the first step, with the help of going over expert we try to recognize variables and effective criteria in supplier selection and the criteria which will be used their revaluation is extracted then the list of appropriate suppliers are find and. In the last stage of the first step, the decision criteria and approved by decision making team. After the approval of decision criteria, we assigned weigh on them. In the last stage of this step, calculated weight of the criteria are approved by decision making team. Finally in the third step, ranks are determined using Topsis Method.

Schematic diagram of the proposed model for weapon selection is provided in figure 1.

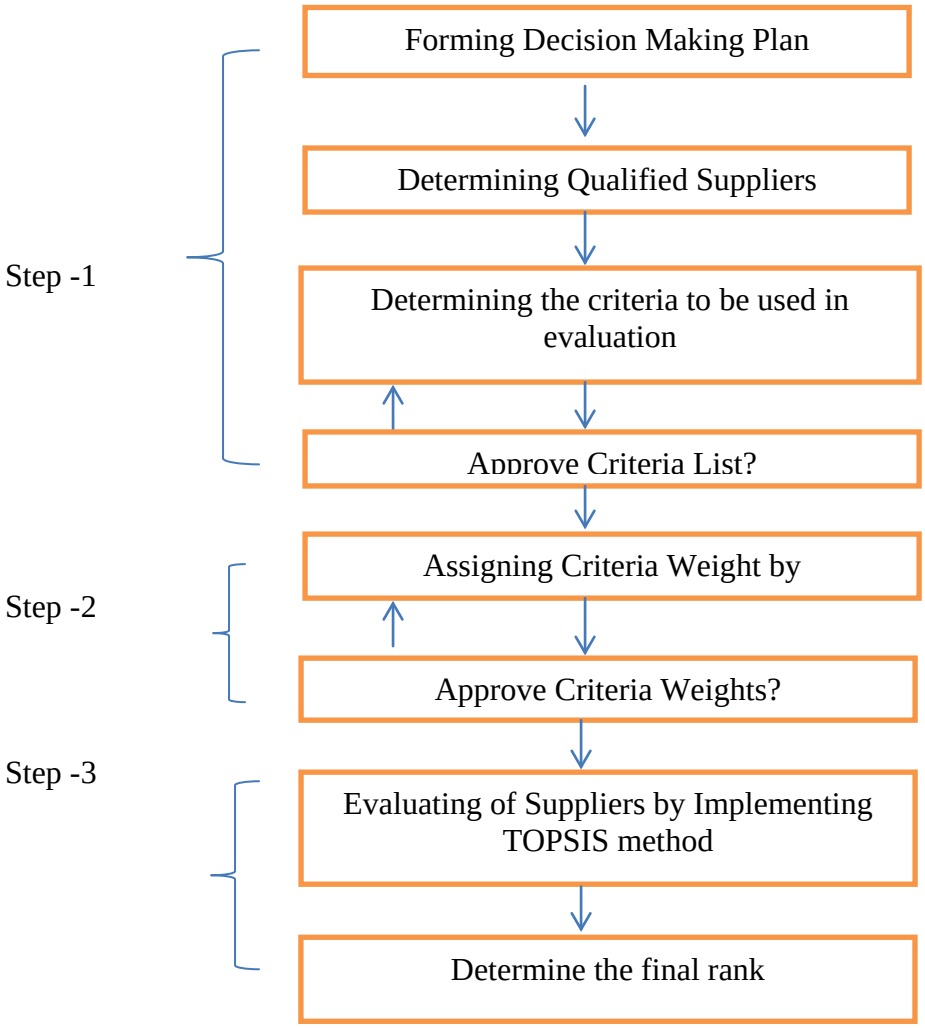

Figure 1. Schematic Diagram of the proposed methodology

Topsis Process

TOPSIS process was introduced for the first time by Yoon & Hwang and was appraised by surveyors and different operators [6]. As large number of potential available vendors in the current marketing environment, a full ANP decision process becomes impractical in some cases. To avoid an unreasonably large number of pair-wise comparisons, we choose TOPSIS as the ranking technique because of its concept's case of use. Also, ANP is adopted simply for the acquisition of the weights of criteria. First, a general TOPSIS process with six activities is listed below [2]:

ACTIVITY: 1) Establish a decision matrix for the ranking. The structure of the matrix can be expressed as follows:

$$D = \begin{array}{c} \\ A_1 \\ .... \\ A_n \end{array} \begin{array}{c} \begin{array}{cccc} B_1 & B_2 & ..... & B_n \end{array} \\ \begin{bmatrix} P_{11} & P_{12} & ..... & P_{1n} \\ ..... & ..... & ..... & ..... \\ P_{m1} & P_{m2} & ..... & P_{mn} \end{bmatrix} \end{array} \quad (1)$$

Where A_i denotes the alternatives i, i = 1…., m; B_j represents j^{th} attribute or criterion, j = 1…., n, related to i^{th} alternative; P_{ij} is a crisp value indicating the performance rating of each alternative A_i with respect to each criterion B_j.

ACTIVITY: 2) Calculate the normalized decision matrix Q= [S_{ij}]. The normalized value S_{ij} is calculated as;

$$S_{ij} = -P_{ij} / \sqrt{\sum_{j=1}^{n} P_{ij}^2}$$

$$i = 1 \ldots\ldots n; \quad j = 1\ldots..m \qquad (2)$$

ACTIVITY: 3) Calculate the weighted normalized decision matrix by multiplying the normalized decision matrix by its associated weights. The weighted normalized value V_{ij} is calculated as:

$$V_{ij} = W_{ij}.S_{ij} \text{ , } j=1\ldots\ldots\ldots n; \quad i= 1 \ldots\ldots\ldots m; \qquad (3)$$

Where w_j represents the weight of the j^{th} attribute or criterion.

ACTIVITY: 4) Determine the PIS and NIS, respectively:

$V^+ = \{v_1^+ \ldots\ldots\ldots.. v_n^+\}$

$= \{(\text{Max vij} \quad I \quad j \text{ c } J), (\text{Min} \quad \text{vij} \quad I \quad j \quad € \quad J')\}$

$V^- = \{v_1^- \ldots\ldots\ldots.. v_n^-\}$

$= \{(\text{Min vij} \quad I \quad j € J), (\text{Max} \quad \text{vij} \quad I \quad j \quad € \quad J')\}$

Where J is associated with the position criteria and J' is associated with the negative criteria.

ACTIVITY: 5) Calculate the separation measures using the m-dimensional Euclidean distance. The separation measure E_i^+ of each alternative from the PIS is given as:

$$E_i^+ = \sqrt{\sum_j^n =1 (V_{ij} - V_j^+)^2} , i = 1.....m \quad (4)$$

Similarly the separation measure E_i^- of each alternative from the NIS is as follows:

$$E_i^- = \sqrt{\sum_j^n =1 (V_{ij} - V_j^-)^2} , i = 1.....m \quad (5)$$

ACTIVITY: 6) Calculate the relative closeness to the idea solution and rank the alternatives in descending order. The relative closeness of the alternative Ai with respect to PIS V+ can be expressed as:

$$H_i^* = E_i^- / E_i^+ + E_i^- \quad (6)$$

Where the index value of H_i^* lies between 0 and 1. The larger the index value, the better the performance of the alternatives.

NUMERICAL PROBLEM

To apply this Topsis Method we have solved simulated numerical example. Based on proposed methodology, 3 Steps are applied for assessment and supplier selection. In this example we assume 6 criteria and 10 suppliers.

After decision making team, step 1 starts developing an updated pool of supplier selection criteria for the industry, using those accepted criteria recommended by the experts. In this numerical example, the criteria are selected as shown in Table 1. Although, the criteria considered in supplier evaluation are condition-industry specific. Selection of criteria is totally industry specific and based on each case and the criteria are changed and replaced. Opinions of decisions makers on criteria were aggregated and weights of all criteria have been calculated by organizing the expert meeting. Its results have assuming 10 suppliers are included in the evaluation process, information of each of suppliers are included in the evaluation process, information of each of suppliers has been mentioned in Table 2. After normalizing information and considering weight of criteria in them, negative and positive

separation measures, based on normalized Euclidean distance for each supplier is calculated and then final weight of each supplier is calculated [3].

Table 1.Selecting Criteria for Supplier Evaluation and weight of Criteria

Code	Criteria	Weight (%)
C_1	Minimum Quantity	0.3
C_2	Maximum Quantity	0.2
C_3	Defective item	0.1
C_4	Late Delivery	0.1
C_5	Product Price	0.14
C_6	Order Quantity	0.16

Step-1 Developing Decision Matrix;

Table-2 Supplier's Information

Supplier→ Criteria ↓	1	2	3	4	5	6	7	8	9	10
C_1	500	600	400	700	100	800	300	225	115	350
C_2	1000	1200	900	1400	400	1200	1100	550	300	800
C_3	50	40	30	75	20	30	35	45	15	25
C_4	75	50	60	80	25	70	85	65	26	68
C_5	55	70	50	90	60	95	88	85	20	78
C_6	700	800	600	1000	250	900	750	400	225	575

Step-2Calculating the Normalized Decision Matrix;

$$S_{ij} = P_{ij} / \sqrt{\sum (P^2_{ij})}$$

Table-3

Criteria → Supplier↓	C_1	C_2	C_3	C_4	C_5	C_6
1.	0.338	0.332	0.395	0.373	0.239	0.331

2.	0.405	0.398	0.316	0.249	0.305	0.378
3.	0.270	0.299	0.236	0.299	0.217	0.284
4.	0.473	0.465	0.592	0.398	0.392	0.473
5.	0.067	0.132	0.158	0.124	0.261	0.118
6.	0.541	0.398	0.237	0.348	0.414	0.425
7.	0.202	0.365	0.276	0.423	0.384	0.355
8.	0.152	0.182	0.355	0.323	0.371	0.189
9.	0.077	0.099	0.118	0.129	0.087	0.106
10.	0.236	0.265	0.197	0.338	0.340	0.272

Step-3 Calculating the weighed normalized decision matrix;

$\mathbf{V_{ij} = W_{ij} . S_{ij}}$

Table -4

Criteria → Supplier↓	C_1	C_2	C_3	C_4	C_5	C_6
1.	0.101	0.066	0.039	0.037	0.033	0.053
2.	0.122	0.079	0.032	0.025	0.043	0.060
3.	0.081	0.059	0.024	0.029	0.030	0.045
4.	0.142	0.093	0.059	0.039	0.055	0.076
5.	0.020	0.026	0.015	0.012	0.037	0.019
6.	0.162	0.079	0.023	0.035	0.058	0.068
7.	0.061	0.073	0.027	0.042	0.054	0.057
8.	0.046	0.036	0.035	0.032	0.052	0.030
9.	0.023	0.019	0.012	0.013	0.012	0.017
10.	0.071	0.053	0.019	0.034	0.048	0.043

Step-4 Determine the PIS and NIS

V^+ = [0.162, 0.093, 0.059, 0.042, 0.058, 0.076]

V^- = [0.020, 0.019, 0.012, 0.012, 0.012, and 0.017]

Step-5 Calculating separation Measure E_i^+

Table-5

Supplier	$E^+ = [\sum (V_i^+ - V_{ij})^2]^{1/2}$
1.	0.077
2.	0.057
3.	0.104
4.	0.020
5.	0.176
6.	0.040
7.	0.109
8.	0.139
9.	0.182
10.	0.112

Calculating separation Measure E_i^-

Table-6

Supplier	$E^- = [\sum (V_i^- - V_{ij})^2]^{1/2}$
1.	0.108
2.	0.132
3.	0.082

4.	0.169
5.	0.026
6.	0.170
7.	0.095
8.	0.060
9.	0.003
10.	0.079

Step-6 Separation measures and the relative closeness coefficient;

Table-7

Suppliers	Closeness Coefficient $H^{-+} = E^{-} / (E^{-}+E^{+})$	Rank
1.	0.583	4
2.	0.698	3
3.	0.440	6
4.	0.894	1
5.	0.128	9
6.	0.809	2
7.	0.465	5
8.	0.302	8
9	0.016	10
10.	0.414	7

Thereafter, the relative closeness coefficients are determined, and ten suppliers are ranked. Obtained results have been mentioned in Table-7. Thus, supplier 4 has the best score amongst 10 suppliers.

CONCLUSION

For a manufacturing industry it is very important to do work with good coordination between management and supplier in term of quality, quantity cost and time. By this approach clear that supplier selection for an industry involves multiple criteria which show important role in selection of suppliers. Using TOPSIS Method provides a useful approach for manufacturing industries for selecting the suitable supplier for them.

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