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Implementation of TOPSIS Technique for Supplier Selection

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Abstract - *In today's highly competitive environment, an effective supplier selection process is very important to the success of any manufacturing organization. Supplier selection is a multi-criterion problem which includes both qualitative and quantitative factors (criteria). A number of models and techniques have been developed to deal with selecting and evaluating suppliers. The objective of this paper is to develop a methodology to evaluate suppliers in supply chain cycle based on Technique for Order Preference by Similarity to Ideal Solution method (TOPSIS). To understand this method a numerical example is proposed to illustrate the effectiveness of TOPSIS method.*

Key Words: *Supplier Selection Process, MCDM, TOPSIS Method,*

1. INTRODUCTION

Multi-criteria decision making (MCDM) refers to making choice of the best alternative from among a finite set of decision alternatives in terms of multiple, usually conflicting criteria. Multi-criteria decision making techniques are useful tools to help decision maker(s) to select options in the case of discrete problems. Especially, with the help of computers, those methods have become easier for the users, so they have found great acceptance in many areas of decision making processes in economy or management.

The prime focus this paper is TOPSIS method, which was presented by Hwang and Yoon and developed later by many authors in their research work. The acronym TOPSIS stands for Technique for Order Preference by Similarity to the Ideal Solution. In general, the process for the TOPSIS algorithm starts with forming the decision matrix representing the satisfaction value of each criterion with each alternative. Next, the matrix is normalized with a desired normalizing scheme, and the values are multiplied by the criteria weights. Subsequently, the positive-ideal and negative-ideal solutions are calculated, and the distance of each alternative to these solutions is calculated with a distance measure.

Finally, the alternatives are ranked based on their relative closeness to the ideal solution. The TOPSIS technique is helpful for decision makers to structure the problems to be solved, conduct analyses, comparisons and ranking of the alternatives.

2. LITERATURE REVIEW

Organizations must work with several suppliers to continue its activities. Selection of the suppliers in a group of candidate firms is a difficult decision problem. In these circumstances, supplier selection is vital for the firms. Determining the best supplier is the key for success to the companies with respect to strategic sense.

The TOPSIS method was first developed by Hwang & Yoon and ranks the alternatives according to their distances from the positive ideal and the negative ideal solution, i.e. the best alternative has simultaneously the shortest distance from the ideal solution and the farthest distance from the negative ideal solution. The ideal solution is identified with a hypothetical alternative that has the best values for all considered criteria whereas the negative ideal solution is identified with a hypothetical alternative that has the worst criteria values. In practice, TOPSIS has been successfully applied to solve selection/evaluation problems with a finite number of alternatives because it is intuitive and easy to understand and implement. Furthermore, TOPSIS has a sound logic that represents the rationale of human choice and has been proved to be one of the best methods in addressing the issue of rank reversal. In multiple attribute decision making (MADM) problem, a decision maker (DM) has to choose the best alternative that satisfies the evaluation criteria among a set of candidate solutions [1, 3, 4, 8, 13]. It is generally hard to find an alternative that meets all the criteria simultaneously, so a better solution is preferred. The TOPSIS method was developed for multi-criteria optimization of complex systems. This method focuses on ranking and selecting from a set of alternatives in the presence of conflicting criteria. Multi criteria optimization is the process of determining the best feasible solution according to the established criteria (representing different effects). Practical problems are often characterized by several non-commensurable and conflicting criteria and there may be no solution satisfying all criteria simultaneously.

3. TOPSIS METHODOLOGY

A Multi-Criteria Decision Making (MCDM) technique helps the decision makers (DMs) to evaluate the best alternatives. TOPSIS method is a most common technique of multi-Attribution Decision Making (MADM) models. "Technique for Order Preference by Similarity to Ideal Solution (TOPSIS)" is a method of multi-criteria decision analysis and this method

was introduced by Hwang and Yoon in 1981. TOPSIS logic is rational and understandable. It chooses the alternative which has the shortest geometric distance from the positive ideal solution and compares a set of alternatives by identifying weights for each criterion, normalizes the scores for each criterion and calculates the geometric distance between each alternative and the ideal alternative in order to give the best score for each criterion. TOPSIS method helps to choose the right suppliers with a various finite number of criteria.

Step 1: The structure of matrix

D =

	X_1	X_2	…	X_j
A_1	X_{11}	X_{12}	…	X_{1j}
A_2	X_{21}	X_{22}	…	X_{2j}
.	.	.	…	.
.	.	.	…	.
A_i	X_{i1}	X_{i2}	…	X_{ij}

Step 2: Calculate the Normalized the matrix D by using the following formula:

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{j=1}^{J} x_{ij}^{\,2}}}$$

Step 3: Construct the weighted normalized decision matrix by multiplying:

$$V_{ij} = w_{ij} . r_{ij}$$

Step 4: Determine the positive ideal solution and negative ideal solution

$$A^* = \{(max\ v_{ij} | j \in J), (min\ v_{ij} | j \in J')\}$$

$$A^- = \{(min\ v_{ij} | j \in J), (max\ v_{ij} | j \in J')\}$$

Step 5: Calculate the separation measure

$$S_i^* = \sqrt{\sum_{j=1}^{n} (v_{ij} - v_j^*)^2}$$

$$S_i^- = \sqrt{\sum_{j=1}^{n} (v_{ij} - v_j^-)^2}$$

Step 6: Calculate the relative closeness to the ideal Solution

$$C_i^* = S_i^- / (S_i^* + S_i^-),\ 0 \le C_i^* \le 1$$

Step 7: Calculate the total score and select the alternative closest to 1.

4. TOPSIS IMPLEMENTATION WITH EXAMPLE

A manufacturing firm needs to purchase a number of portable generator. The selection based on four suppliers and the features of the product they wish to supply as the criteria. The evaluation objectives and choose the best of them. The evaluation group determines the value of each criterion which is based on the 10 pointer scale as shown in the table 1. The selected criterions having equal weightage as all of the selection criterion are equally important for the manufacturing firm.

The selection criterions are Price (P), Fuel Consumption (FC), Product Life (PL) and Maintenance Cost (MC).

Table 1 Four Criterions of the Supplier and their attributes

Selection Criteria → / **Rating ↓**	**Price**	**Fuel Consumption**	**Product Life**	**Maintenance Cost**
6	Low			
7	High			
8	Very High			
9	Extremely High			

Table 2: Criterion Parametric values

Selection Criteria → / **Alternatives ↓**	**P**	**FC**	**LC**	**MC**
Supplier 1	9	7	8	9
Supplier 2	7	8	7	7
Supplier 3	8	8	7	7
Supplier 4	6	9	9	6

4.1 TOPSIS CALCULATIONS

Step 1: The structure of matrix

Table 3 Criterion Parametric values

Selection Criteria → / Alternatives ↓	P	FC	PL	MC
Supplier 1	9	7	8	9
Supplier 2	7	8	7	7
Supplier 3	8	8	7	7
Supplier 4	6	9	9	6
$\sum_{i=1}^{m} x_{ij}$	30	32	31	29
$\sqrt{\sum_{i=1}^{m} x_{ij}^2}$	15.2	16.06	15.59	14.66

Step 2: Calculate the Normalized the matrix by using the mentioned formula in methodology section.

Table 4: Normalized Matrix

Selection Criteria → / Alternatives ↓	P	FC	PL	MC
Supplier 1	0.59	0.44	0.51	0.61
Supplier 2	0.46	0.50	0.45	0.48
Supplier 3	0.53	0.50	0.45	0.48
Supplier 4	0.40	0.56	0.58	0.41

Step 3: Construct the weighted normalized matrix by multiplying weight and normalized matrix, as in the problem the weight of the four criterions are equal, therefore 0.25 is consider as the weight.

Table 5 Weighted Normalized Matrix

Selection Criteria → / Alternatives ↓	P	FC	PL	MC
Supplier 1	0.15	0.11	0.13	0.15
Supplier 2	0.12	0.13	0.11	0.12
Supplier 3	0.13	0.13	0.11	0.12
Supplier 4	0.10	0.14	0.15	0.10

Step 4: Determine the positive ideal solution and negative ideal solution.

Table 6 Positive and Negative Ideal Solution

A^+	0.10	0.14	0.15	0.10
A^-	0.15	0.11	0.11	0.15

Step 5: Calculate the separation measure for suppliers.

Table 7 Separation Measure for suppliers

	Supplier 1	Supplier 2	Supplier 3	Supplier 4
S^*	0.10	0.14	0.15	0.10
S^-	0.15	0.11	0.11	0.15

Step 6: Calculate the relative closeness to the ideal Solution

Table 8 Relative Closeness Coefficient

Supplier ↓	S^*	S^-	S^*+S^-	$C^+= S^-/(S^*+S^-)$
Supplier 1	0.08	0.02	0.10	0.20
Supplier 2	0.05	0.05	0.10	0.49
Supplier 3	0.06	0.41	0.10	0.43
Supplier 4	0.00	0.08	0.08	1.00

5. RESULT AND CONCLUSIONS

In this paper, the calculation algorithm is done properly and the results were reached within the framework of the objectives set for the supplier. In this study supplier 4 was the most suitable supplier for further procurement process.

The prime focus was how to select the best supplier in supplier selection problems when decision makers set the target value of each criterion. Although many approaches can solve the problem, the study proposed a method and a procedure to extend the TOPSIS method to solve the problem. The main advantages of using TOPSIS method are "TOPSIS logic is rational and understandable", "The

computation processes are straightforward", "The concept permits the pursuit of best alternatives criterion depicted in a simple mathematical" and "The importance weights are incorporated comparison procedures". Due to this, decision making for selection of suitable supplier is of special importance.

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