A TOPSIS METHOD-BASED APPROACH TO VENDOR SELECTION

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ABSTRACT

A supply chain plays very vital role in the manufacture of a product from the procurement of raw materials to the distribution of the final products to the customer. The manufacturing function has gained importance in the supply chain management due to factors such as globalization, increased value addition in supply and accelerated technology change. The most important process of the manufacturing function is the efficient selection of vendor, because it brings significant savings for the organization.

In general, most commonly used vendor selection criteria by the industries are quality, delivery and price etc. Decision makers always consider many criteria in vendor selection problem in manufacturing to select their best vendor. Hence, vendor selection problem belongs to the multiple criteria decision making (MCDM) problem. Weightages are calculated for different attribute by using Aggregation of individual judgements (AIJ) method. There are many approaches to solve the MCDM problem. In this paper the TOPSIS techniques for ranking of vendor is used so as to select best vendor.

KEYWORDS

TOPSIS, Multiple criteria decision making (MCDM), Aggregation of individual judgements (AIJ), DELPHI,

INTRODUCTION

Control panel is a heart of Robot which comprises 70% Bought out parts directly from the ultimate vendors and 30% in house assembly. If we look at this complete as a product the first question is coming in mind, Is the small amount of in house assembly is really helpful for the product considering the parameters Man, Method, Machines and Money? This in-house assembly though it is 30% but utilizes resources, labor, machinery, time, cost, electricity significantly. In addition to this, for 30% in house assembly we need to disturb 70% assembly already made by the vendor and for that we already paid the cost. The In-house assembly is carried out after inversion of the panel. In short, it's like reworking on complete control panel to do the assembly.

It's obvious that reopening of control panel will have human errors and ultimately results in to the quality issue which will be even worse at the customer place. Analysis is carried out for completely outsourcing of control panel so as to reduce all human

error as well as cost saving. Also aiming to select vendor based on low lead time for minimizing uncertainty. Katikar R S, Dr. Pawar M.S [1] was used TOPSIS method in the selection of supplier for the application of purchasing, procurement or buying of components or getting a service to meet the demand of customers or run the business. The criteria used for vendor selection in manufacturing outsourcing are unit cost of component, quality of component, manufacturing capability, flexibility and delivery performance for variation in order sizes.

The main objective of vender selection process is to identify vendors with the highest potential for meeting the needs consistently and at an acceptable overall performance. Selecting vendors from a large number of possible vendors is a difficult task. Vendor selection is a complex multi criteria decision problem that can include both qualitative and quantitative factors.

LITERATURE REVIEW

Srikrishna S and Sreenivasulu Reddy.(2) proposed that decision-making method for selecting the best car. Important criteria's while selection include: fuel economy, comfort and convenience features, life span, suspension, style and cost. Dr. Bhatt Rajiv & Dr. Bhatt Darshana(3) has researched on Supplier Selection for Construction Projects Through 'TOPSIS' and 'VIKOR' Multi-Criteria Decision Making Methods. In this paper AHP technique is integrated with TOPSIS and VIKOR methods for supplier selection in construction project for purchase of cement. Emrah Onder and Sundus Dag(4) has completed his research on Combining Analytical Hierarchy Process And TOPSIS Approaches For Supplier Selection In A Cable Company. The aim of this paper is to determine the appropriate supplier providing the most customer satisfaction for the criteria identified in the supply chain.

Mst. Nazma Sultana, Md. Habibur Rahman and Abdullah Al Mamun(5) proposed review article on Multi Criteria Decision Making Tools for Supplier Evaluation and Selection. Multi Criteria Decision making tools (MCDM) have been included in this paper to take the decision and to select the suppliers more accurately and makes a reflection on the effective suppliers selection criteria like supplier reliability, product quality and supplier experience etc. F. Ghaemi-Nasaba, S.Mamizadeh-Chatghayeh(6) applied DEA-TOPSIS method for supplier selection. This paper based on a DEA-TOPSIS method for MADM problems a flexible strategy for supplier selection is introduced. Krishnendu Mukherjee(7) completed his analysis for Supplier selection criteria and methods: past, present and future. Considering some issue an attempt has been made in this paper to give systematic review of supplier selection and evaluation process from 2005 to 2012. Gregory J. Skulmoski Zayed, Francis T. Hartman and Jennifer Krahn(8) researched on The Delphi Method for Graduate Research. Very few researcher Choy, K.L., Lee, W.B. Eleonora Bottani, Antonio Rizzi, Liang-Hsuan Chen; Chia-Chang Hung(9) make use the TOPSIS method in vendor selection in manufacturing outsourcing.

Weijun Xia and Zhiming Wu(10) has researched on Supplier selection with multiple criteria in volume discount environments. In this article an integrated approach of analytical hierarchy process improved by rough sets theory and multi-objective mixed

integer programming is proposed to simultaneously determine the number of suppliers to employ and the order quantity allocated to these suppliers in the case of multiple sourcing. Nilesh R. Warea, S. P. Singh and D. K. Banwet[(11)] has completed their review on Supplier selection problem: A state-of-the-art.

METHODOLOGY

Supplier Selection Process –

The first step of supplier selection is "Problem Definition"- concerns decision makings which should identify the strategy of purchases e.g. the duration of new selection. Second step consisting of identifying the key criteria and determining the sourcing strategy. Pre-qualification, the third step is the process of identifying potential supply source and gathering a limited pool of suppliers. The last step in the supplier selection process is final selection. Best supplier is selected from firstly selected supplier. While qualitative tools are used in the first two steps, quantitative tools are used in last two steps.

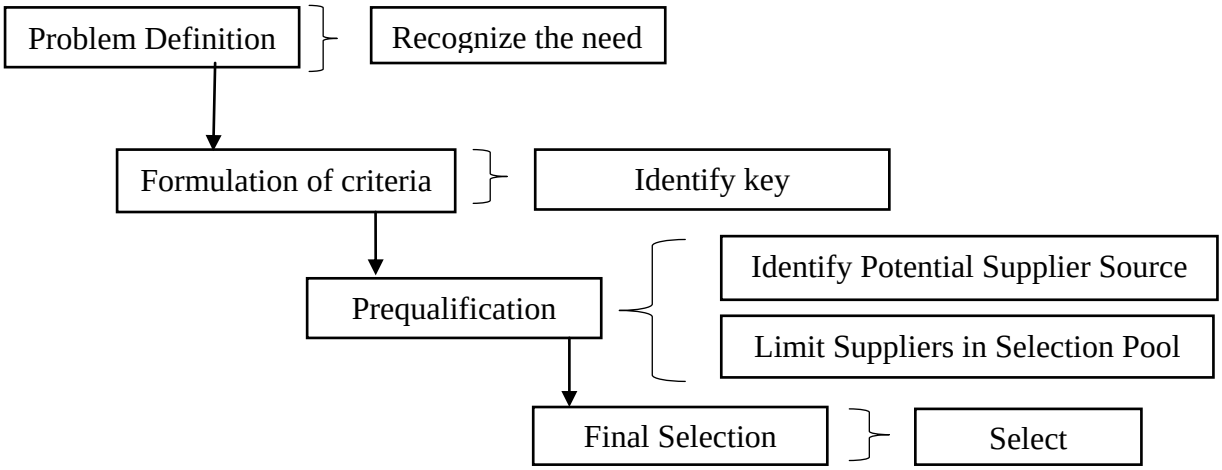


Fig.1 Supplier Selection Process

The objective of this work is to develop TOPSIS method for vendor selection. In order to comply with collecting quantitative and qualitative data for TOPSIS vendor selection model that could be applied by a seven steps approach was performed to ensure successful implementation.

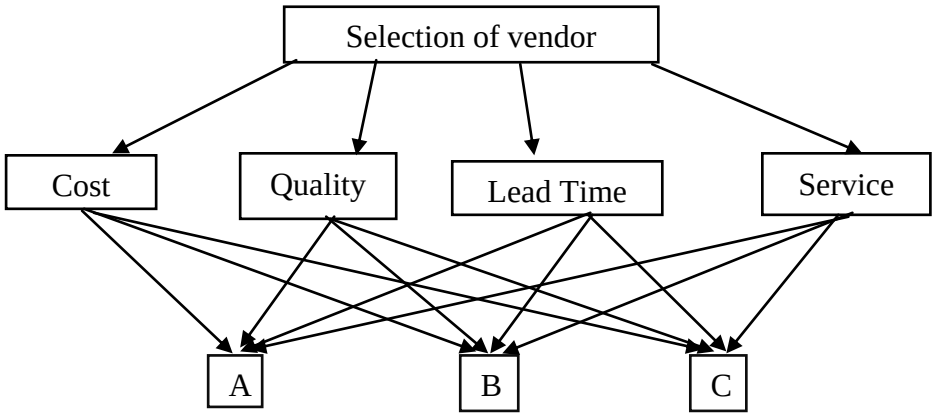


Fig.2 Selection criteria of TOPSIS

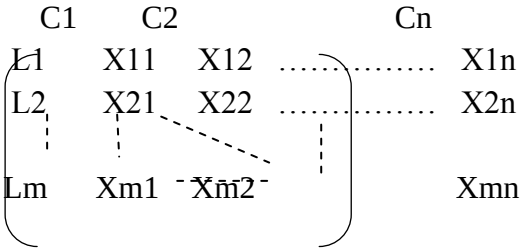
Selection of a supplier for manufacturing firm is a big decision-making problem and reflection of customer satisfaction. Some of the main criteria of material are cost, quality, lead time, service. There are three existing vendors for procurement of control panel. The correlation chart is shown in figure 2.

TOPSIS Method-

P.K. Parida and S.K.Sahoo[(12)] states that TOPSIS was first presented by Yoon (1980) and Hwang and Yoon (1981), for solving Multiple Criteria Decision Making (MCDM) problems based on the concept that the chosen alternative should have the shortest Euclidian distance from the Positive Ideal Solution (PIS) and the farthest from the Negative Ideal Solution (NIS). For instance, PIS maximizes the benefit and minimizes the cost, whereas the NIS maximizes the cost and minimizes the benefit. It assumes that each criterion require to be maximized or minimized. TOPSIS is a simple and useful technique for ranking a number of possible alternatives according to closeness to the ideal solution.

Mathematically the application of the TOPSIS method involves the following steps.

Step 1: Determine the objective and identify the pertinent evaluation criteria.



Decision matrix based on all the information available for the criteria. Each row of the decision matrix is allocated to one alternative and each column to one criterion. Therefore, an element, xij of the decision matrix shows the performance of ith alternative with respect to jth criterion.

	Cost	Quality	Lead time	Service
A	75000	Good	40	Best
B	73819	Best	30	Better
C	77000	Better	30	Good

Table 1. Data collection for different attribute

Good is considering between 5-6, better is considering between 7-8, best is considering between 9-10 as per export opinion. Hence revised table is-

	Cost	Quality	Lead time	Service
A	75000	5	40	9
B	73819	9	30	8
C	77000	7	30	6

Step 2: Calculate weightages for TOPSIS methodology by using DELPHI method.

The Delphi method belongs to the subjective-intuitive methods of foresight. Delphi was developed in the 1950's by the Rand Corporation, Santa Monica, California, in operations research. Consensus method such as Delphi survey technique are being employed to help enhance effective decision making. The Delphi survey is a group

facilitation technique, which is an iterative multistage process, designed to transfer opinion into group consensus.

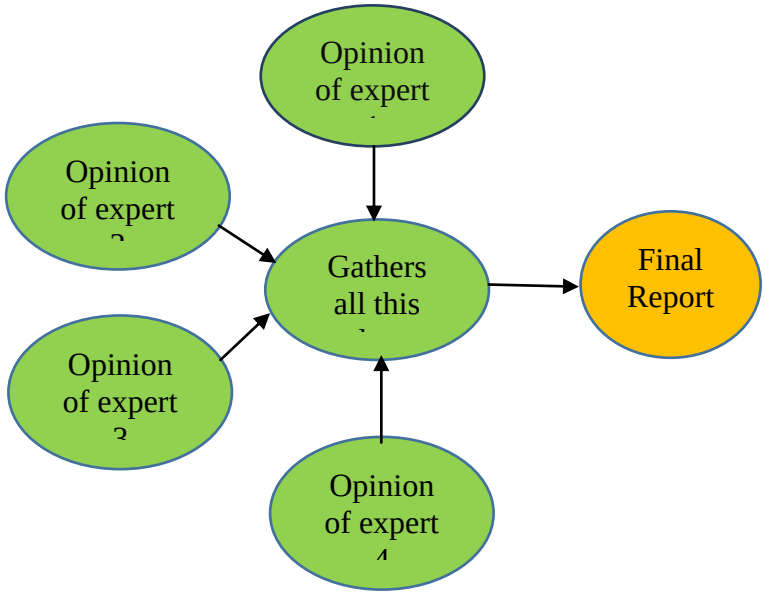


Fig 3. Delphi method

2.1. Delphi expert consultation

Guofeng Chen et all[13] studied on Research and Implementation of Index Weight Calculation Model for Power Grid Investment Returns. Delphi method, entropy method are used to calculate the weight, and finally combination of three methods to calculate the weight, get the Combination weights. Shi-Fan Han[14] researched on Construction of an evaluation index system for the innovativeness of nursing papers using the Delphi method.

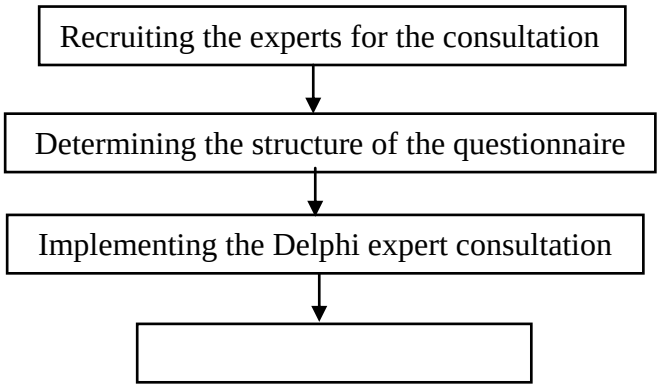


Fig 4. Implementation of DELPHI method

2.1.1. Recruiting the experts for the consultation

A total of four experts specializing in purchase, quality work for firm were preliminarily selected to conduct the Delphi expert consultation. The inclusion criteria for the experts were as follows: engaged in the peer review and editorial work of manufacturing outsourcing and quality inspection for more than 3 years; with an associate senior title or above; having a bachelor degree or above; and interested in and willing to participate in this study. So selected experts are A, B, C, D.

2.1.2. Determining the structure of the questionnaire

The questionnaire was composed of scoring of four criteria: the qualitative data is mentioned as good, better, best. All items in the table were scored using-10 point scoring system: Based on satisfaction. An additional column was set for expert's comments in revision. Give rating for attribute- cost, quality, lead time, service in the scale 1-10.

2.1.3. Implementing the Delphi expert consultation

From past experience of various vendors, the round of expert consultations was conducted; The rounds of consultation were implemented by distributing the questionnaire in person via written format.

Attributes	A	B	C	D
Cost	7	8	7	8
Quality	6	7	6	6
Lead time	6	7	6	6
Service	5	5	5	5

Table 2. Data collection from DELPHI

2.1.4. Calculate the weightages by using Aggregation of individual judgements (AIJ)

R. Venkata Rao[(15)] studied on Aggregation of individual judgements (AIJ) in "Decision Making in the Manufacturing Environment" for calculating weightages of attribute. It is assumed that several individuals act as one individual and their judgements, i.e., the opinions expressed regarding the relative importance of the attributes, are aggregated using the weighted geometric mean to form a single composite attribute weight representing the total view of the group.

There are n decision makers (g(k), k = 1, 2, ….. , n)

lg(k) is the importance of the decision maker in the group, and ∑lg(k)= 1.

bij (AIJ) =Π (bij g(k))$^{lg(k)}$

Importance of decision maker	70	80	50	60
Attributes	A	B	C	D
Cost	7	8	7	8
Quality	6	7	6	6
Lead time	6	7	6	6
Service	5	5	5	5

Table 3. Importance to respective decision maker

Importance of decision maker are in the range (10-100).Score for different attribute given by decision maker are in the range (1-10)

Normalization for decision maker importance-

lg(k)	0.269231	0.307692	0.192308	0.230769

Hence matrix (bij g(k))$^{lg(k)}$ is given below

1.688598	1.896155	1.453847	1.615866
1.619952	1.819827	1.411382	1.512075
1.619952	1.819827	1.411382	1.512075
1.542355	1.640846	1.362754	1.449776

Weightages for attribute are calculated by **bij (AIJ) = Π (bij g(k))$^{lg(k)}$**

Cost	0.299619
Quality	0.250608
Lead time	0.250608
Service	0.199166

Table 4. Result of Aggregation of individual judgements (AIJ)

Step 3: Calculate a normalized decision matrix

The normalized values denote the Normalized Decision Matrix (NDM) which represents the relative performance of the generated design alternatives.

Dij=(Xij /[∑Xij²]½)*Wj (j=1,2,…..M) (1)

	Cost	Quality	Lead time	Service
A	5625000000	25	1600	81
B	5449244761	81	900	64
C	5929000000	49	900	36
SUM	17003244761	155	3400	181
ROOT	130396.4906	12.4499	58.30952	13.45362

Step 4: Calculate a weighted normalized decision matrix

Hence Weighted Normalized matrix is-

Weightage	0.29961867	0.250607846	0.25060785	0.19917
	Cost	Quality	Lead time	Service
A	0.172331328	0.100646533	0.171915564	0.133235
B	0.169617684	0.18116376	0.128936673	0.118431
C	0.17692683	0.140905146	0.128936673	0.088823

Step 5: Obtain the ideal (best) and the negative ideal (worst) solutions using the following equations:

Cost and lead time are nonbeneficial, service and quality are beneficial.

V+={(∑Vij/j∈J)[i=max],(∑Vij/j∈J')[i=min]/i=1,2….N} (2)

V-={(∑Vij/j∈J)[i=min],(∑Vij/j∈J')[i=max]/i=1,2….N} (3)

where, J = (j = 1,2,...,M) /j is associated with beneficial attributes and J'= (j = 1,2,...,M)/j is associated with non-beneficial attributes.

POSITIVE IDEAL SOLUTION	V+	0.169617684	0.18116376	0.128936673	0.133235
NEGATIVE IDEAL SOLUTION	V-	0.17692683	0.100646533	0.171915564	0.088823

Step 6: Obtain the separation measures. The separations of each alternative from the ideal and the negative ideal solutions are calculated by the corresponding Euclidean distances, as given in the following equations:

$Si+=\{\sum(Vij-Vj+)^2\}^{1/2}$ (j=1,2,….M) (i=1,1,…N) (4)

$Si+=\{\sum(Vij-Vj-)^2\}^{1/2}$ (j=1,2,….M) (i=1,1,…N) (5)

	Cost	Quality	Lead time	Service	S+
A	0.00271364	-0.08051723	0.04297889	0	0.09131031
B	0	0	0	-0.0148	0.014803865
C	0.00730915	-0.04025861	0	-0.0444	0.060386831

	Cost	Quality	Lead time	Service	S-
A	-0.004595502	0	0	0.044412	0.044648723
B	-0.007309146	0.080517226	-0.042978891	0.029608	0.096230193
C	0	0.040258613	-0.042978891	0	0.058889227

Step 7: The relative closeness of a particular alternative to the ideal solution is computed as follows:

$Pi = Si-/(Si- + Si+)$ (6)

A	0.328398355	3
B	0.866672755	1
C	0.493722109	2

Table 5. Result of TOPSIS

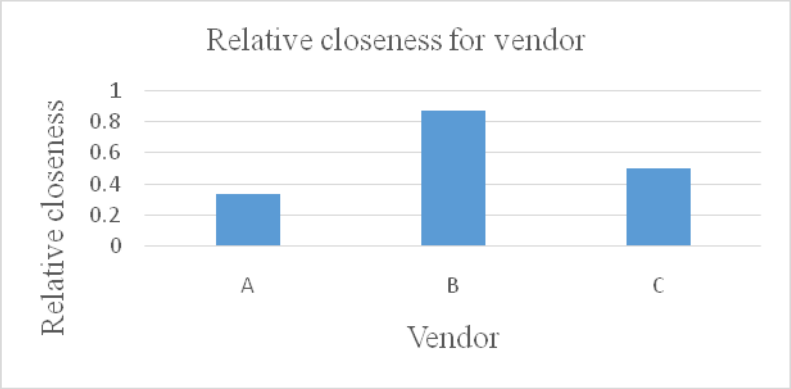


Fig 5. Histogram of different vendors

Step 8: A set of alternatives is arranged in the descending order, according to Pi value, indicating the most preferred and the least preferred solutions. The maximum value is the best one. If the value is lesser than the value of 1, then it is acceptable condition.

B	0.866672755	1
C	0.493722109	2
A	0.328398355	3

Table 6. Ranking of vendor based on TOPSIS

CONCLUSION

The proposed new procedure for vendor selection is to find the best vendor among available ones using of decision making method. TOPSIS is applied to achieve final ranking preferences in descending order; thus allowing relative performances to be compared.

The Delphi survey is a group facilitation technique, which is an iterative multistage process, designed to transfer opinion into group consensus.

From the results it is observed that vendor A, B, C obtained the relative closeness to ideal solution and the values are 0.328398355, 0.866672755, 0.493722109 respectively. It is observed B is identified as the best vendor among the considered ones which has the best relative closeness value

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