Assignment of weight by AHP to Supplier Selection and Evaluation problem

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Abstract-Supplier evaluation is one of the most critical activities of purchasing management in supply chain. Supplier rating is a complex problem involving qualitative and quantitative multi-criteria. Hence the supplier evaluation is multi criteria decision making (MDCM) problem. The typical MCDM problem deals with the evaluation of a set of alternatives in terms of a set of decision criteria. This paper provides a comprehensive survey of some methods for eliciting data for MCDM problems and also for processing such data. This work incorporates the multi criteria decision making methodologies namely Analytical Hierarchy Process (AHP) for definition of supplier selection criteria, assignments of weights to the defined criteria. This Multi Criteria Decision Making Methodologies will significantly reduce the purchasing cost, supports the decision making systems of organization and increase the production efficiency and overall competitiveness.

***Index Terms*-Supplier Evaluation, Multi Criteria Decision Making, Analytical Hierarchy Process, TOPSIS, Grey Relational Analysis**

I. INTRODUCTION

Evaluation and selection of vendors is a critical decision faced by purchasing managers that has significant practical implications. The strategic importance of vendor evaluation process is well documented in the literature. Traditionally, vendor evaluation models were based on financial measures with less emphasis on other tangible and intangible criteria. However, with the widespread use of manufacturing philosophies such as just-in-time (JIT) emphasis has shifted to the simultaneous consideration of multiple vendor attributes in the supplier evaluation process. Thus, methodological developments in vendor evaluation techniques have centered on the consideration of multiple measures that often included important product- and service-related attributes such as price, delivery, and quality performance.

II. LITERATURE REVIEW

The literature in this area discusses either the criteria or methods of supplier selection and evaluation. (giuliano noci, 1997) have designed a conceptual approach that first identifies measures for assessing a supplier's environmental performance and, secondly, suggests effective techniques for developing the supplier selection procedure according to an environmental viewpoint. (flip roodhooft and jozef koinings, 1995) applied activity based costing approach to supplier evaluation and selection model. Here the activities and cost driver are identified to measure the performance of suppliers. (paul briggs, 1994) considered zero as a base score line & representing 'no risk but not ideal'. For ideal answer +ve score and -ve score for risk. (shrinivas tulluri et. Al., 2006) developed a chance constrained data envelopment analysis model for supplier evaluation. (farzad tahriri et. Al., 2008) considered cost, quality, facility, delivery for supplier performance evaluation. The analytical hierarchy process and sensitivity analysis are the techniques are employed for finding the weights and measurement of performance. (kumar and parashar, 2009) have been developed based upon the views of various experts. A well researched methodology has been adopted for the synthesis of priorities and the measurement of consistencies. (desheng wu, 2009) developed a hybrid supplier evaluation model using data envelopment analysis (dea), neural networks and decision trees. (wann-yih wu et. Al,. 2009) presents an integrated multi-objective decision-making process by using analytic network process (anp) and mixed integer programming (mip) to optimize the selection of supplier. (a. Amid et. Al., 2006) suggested a fuzzy multi objective linear model to overcome the vagueness of the information. (juchi hou, 2010) investigated the problem of intuitionist fuzzy multiple attribute decision-making with completely known attribute weight information. (chih hung tsai et. Al., 2003) employed delphi method to calculate the weights of criteria and grey relational analysis to obtain the ranking of suppliers.

III. METHODOLOGY AND RESULTS

Criteria identification and definition
After discussion with buyers and academician the criteria are fixed and defined for Indian automobile industry as follow.
(1) Quality (Q): Numbers of defective parts per millennium. (2) Delivery (D): Number of trigger

given/ Number of trigger followed. (3) Auto sheet number (A): It is measured in percentage as barcode is used to identify the fill rate of sheet. (4) Packaging (P): Packaging density is measured as the type as well as volume is mentioned on the packaging sign of. (5) Communication and Responsiveness(C & R): It is measured in terms of hours required to response for any query. (6) Imitativeness (I): It is concerned with environmental issues and safety in the plant of supplier. (7) Logistics PPM (L): Number of damaged parts in transportation calculated per millennium. The measured value of each criterion is shown in table below.

Table 1.1 Evaluation Matrix

Criteria	D	A	P	I	L	C & R	Q
Supplier1	92	100	78	89	1	24	2
Supplier2	100	84	82	88	100	12	234
Supplier3	71	81	77	75	28	52	120
Supplier4	89	90	87	90	87	72	249
Supplier5	64	94	79	45	16	24	25

Analytical hierarchy process

One of the most popular analytical techniques for complex decision making problems is analytic hierarchy process. Saaty developed AHP, which decomposes a decision making problem in to a system of hierarchies of objectives, attributes and alternatives. In this study AHP is used to calculate weight ages and confirm the consistency. An AHP can have as many levels as needed to fully characterize a particular decision situation. A number of functional characteristics make AHP a useful methodology. These include the ability to handle decision situations involving subjective judgments, multiple decision makers and the ability to provide measures of consistency of preference. Designed to reflect the way people think, AHP continues to be the most highly regarded and widely used decision-making method. AHP can efficiently deal with tangible (objective) as well as non-tangible (subjective) attributes, especially where the subjective judgments of different individuals constitute the important part of the decision process. Further these weight ages are used in GRA method.

To make a decision in an organised way to generate priorities we need to decompose the decision into the following steps.

1 define the problem and determine the kind of knowledge sought.

2 structure the decision hierarchy from the top with the goal of the decision, then the objectives from a broad perspective, through the intermediate levels (criteria on which subsequent elements depend) to the lowest level (which usually is a set of the alternatives).

3 construct a set of pair wise comparison matrices. Each element in an upper level is used to compare the elements in the level immediately below with respect to it.

4 use the priorities obtained from the comparisons to weigh the priorities in the level immediately below. Do this for every element. Then for each element in the level below add its weighed values and obtain its overall or global priority. Continue this process of weighing and adding until the final priorities of the alternatives in the bottom most level is obtained.

To make comparisons, we need a scale of numbers that indicates how many times more important or dominant one element is over another element with respect to the criterion or property with respect to which they are compared.

Table 1.2 Scale

Numerical assessment	**Linguistic meaning**
1	Equal importance
3	Moderately more importance
5	Strongly more importance
7	Very strongly importance
9	Extremely more importance
2,4,6,8	Intermediate value of importance

This above table gives the qualitative important terms in the form of quantitative numbers. It is taken from fuzzy logic technique.

Assuming M attributes, the pair-wise comparison of attribute i with attribute j yields a square matrix BM x M where aij denotes the comparative importance of attribute i with respect to attribute j. In the matrix, bij = 1 when i = j and bji = 1/bij.

$$B_{M\times M} = \begin{bmatrix} 1 & b_{12} & b_{13} & \cdots & \cdots & b_{1M} \\ b_{21} & 1 & b_{23} & \cdots & \cdots & b_{2M} \\ b_{31} & b_{32} & 1 & \cdots & \cdots & b_{3M} \\ \cdots & \cdots & \cdots & \cdots & \cdots & \cdots \\ \cdots & \cdots & \cdots & \cdots & \cdots & \cdots \\ b_{M1} & b_{M2} & b_{M3} & \cdots & \cdots & 1 \end{bmatrix}$$

In this case the pair wise comparison matrix is filled by the buyer of Supply Chain Management department of Mahindra and Mahindra Igatpuri. It is shown as below.

Table 1.3: Pairwise comparison

	Q	**D**	**A**	**P**	**C**	**I**	**L**
Q	1	1	2	1	3	3	1
D	1	1	4	1	3	3	1
A	0.5	0.25	1	1	2	2	1
P	1	1	1	1	1	1	1

C	0.33	0.33	0.5	1	1	1	1
I	0.33	0.33	0.5	1	1	1	1
L	1	1	1	1	1	1	1

Find the relative normalized weight (wj) of each attribute by

(i) Calculating the geometric mean of ith row and

(ii) Normalizing the geometric means of rows in the comparison matrix. This can be represented as:

$$GM_j = \left[\prod_{j=1}^{M} b_{ij}\right]^{1/M}$$

and

$$w_j = GM_j / \sum_{j=1}^{M} GM_j$$

The geometric mean method of AHP is used to find out the relative normalized weights of the attributes because of its simplicity and easiness to find out the maximum Eigen value and to reduce the inconsistency in judgments. The above matrix is treated as A1 matrix in case of consistency test. After preparing the matrix normalize it & find the weight of the each criterion is calculated as follow.

The calculated weights are consistent or not. If the C.R. is less than 0.10 then the weights are consistent. The consistency ratio (C.R.) for the comparison above is calculated to determine the acceptance of the priority weighting.

iii) Calculate matrices A3 and A4 such that A3=A1 * A2 and A4 = A3 / A2, where A2 = [w1, w2… wj]. These calculations were done in Matlab.

Table 1.4: Weights of Criteria

Criteria	GM_j	w_j
Quality	1.511	0.20
Delivery	1.669	0.23
ASN Sheet	0.906	0.12
Packaging	1.000	0.13
Communicatio	0.662	0.09
Initiative	0.662	0.09
Logistics PPM	1.000	0.13

iv) Determine the maximum Eigne Value λmax that is the average of matrix A4.

λmax = 7.6903 (for above A1 and A2 matrix).

v) Calculate the consistency index CI = (λmax – M) / (M-1). The smaller the value of CI, the smaller is the deviation from the consistency. [19].

CI = (7.6903-7) / (7-1) = 0.11505 . . . . . M= 7 number of attributes.

vi) Obtain random index (RI) for the number of attributes used in decision making. Refer below table.

Table 1.5 : Random Index

Criteria	Ri
3	0.52
4	0.89
5	1.11
6	1.25
7	1.35
8	1.4
9	1.45
10	1.49

IV. CONCLUSIONS

In order to seek a proper supplier meeting, it is necessary to develop an accurate supplier selection and evaluation model. The supplier evaluation is mainly depend upon the criteria and weights assigned to criteria. The AHP method is used to assign the weight for criteria. As per AHP Delivery rate and Quality having more importance than other criterion as far as case company concern.

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