

Supplier Evaluation and selection methods in construction industry

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Abstract - The evaluation and selection of suppliers, structuring the supplier base is an important task in any organization. It assumes utmost importance in the current scenario of global purchasing. A supplier evaluation shall comprise all aspects that are important for a well-set and cordial working co-operation between the Customer firm and the supplier. While developing a supplier survey for the purchaser it is to be decided which performance categories to include. The preliminary criteria are cost/price, quality and delivery, which are generally the most obvious and most critical areas that affect the buyer. For most of times, these three performance areas would be enough, however for critical items needing a detail analysis of the supplier's capabilities, a more detailed supplier evaluation study is required. Supplier Evaluation and selection initiates them to adopt the most efficient methods in order to ensure the smooth flow of the execution of the Project, thereby avoiding delay and cost overrun of projects. For achieving better value for money careful detail investigation for supplier evaluation in construction industry is necessary. This paper focus on actual study of supplier evaluation, evaluation criteria and selection methods. This Paper introduce case study in selection of steel and cement supplier in construction industry of India by using AHP mathematical model.

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Key Words: Analytical hierarchy approach, multi-criterion decision making system, supplier evaluation, supply chain management, vendor rating.

1. INTRODUCTION

Supplier evaluation is assessment of new or existing supplier on basis of their delivery, price, production capabilities, qualities of management, technical capabilities and services. A typical Supplier Evaluation

Framework shall be used in all cases where the standard of a supplier for production material is to be defined. It can be used both for existing and potential suppliers. Existing suppliers can also be "coached" with the framework to bring them up to mark and also used to monitor an existing supplier and help in its corrective action. It additionally avails companies in rewarding suppliers for their excellent performance and penalizing them or de-listing them if found otherwise. If a firm or customer organization has sundry divisions and Organizations then the division or SBU that is having the maximum business with a supplier will undertake to do the evaluation. This avails in a strategic focus of the supplier towards the highest buying organization.

Supplier Evaluation and Management is a very strong concept in manufacturing industry, but has to come a long way in the construction Projects. In projects, especially in India, it is considered as a part of the unorganized sector. Its importance is not only in aspects of logistics in projects but also holds an important position in growth and survival of project organization itself. The Supplier cull study in Construction supply chain management is relatively unexplored in Indian context. Much enlightened business had commenced with this concept with the avail of experts and consulting firms. However, expectedly Indian enterprises had not taken this approach thus far. This study would be a paramount approach towards integrating vendors in the Construction supply chain management and ameliorates its deliverables.

1.1. SUPPLIER EVALUATION SYSTEM

The three general types of supplier evaluation systems used today are;

- Categorical method,
- Cost-Ration method,
- Linear averaging method.

The guiding factor in deciding which system is best is;

- Ease of implementation &
- Overall reliability of system.

It should be noted that implementation of the results is the matter of the buying organization's judgement. [2]

1.1.1 Categorical method:

This method involves categorizing each supplier's performance in specific area defined by a list of relevant performance variables. The buyer develops a list of performance factors for each supplier and keeps track of each area by assigning a 'grade' in simple terms, such as 'good, neutral, unsatisfactory'. In the meetings with the supplier the buyer informs him of his performance.

The advantage associated with this type of evaluation is that it can be implemented immediately and is least expensive. The disadvantage is dependence on the judgment of the user. With this method there is on concrete supporting data. (6)

1.1.2 Cost-Ratio method:

This method evaluates supplier performance using standard cost analysis. The total cost of each purchase of material is calculated as its selling price plus the buyer's internal organizational cost associated with the quality, delivery and service elements of purchase.

Calculation involves four step processes;

1. Determine the internal organizational cost associated with the quality, delivery and service.
2. Convert each element to cost ratio, which expresses the cost as percentage of the value of the purchase.

3. Sum up the three cost ratio (quality, delivery and service) to obtain overall cost ratio.

4. The overall cost ratio is applied to suppliers quoted price to obtain the net adjusted cost figure.

The net adjusted cost figure is used to compare the performance of various suppliers. [2]

1.1.3. Linear averaging method:

This method is the most commonly used evaluation method. Specific quantitative performance factors are used to evaluate supplier performance. The most commonly used factors are quality, service (delivery) and price, although any one factor may be give more weight than others. The assignment of these weights is a matter of judgment of top management preferences. These weights are subsequently used as multipliers for the individual ratings on each of the three performance factors. After the weights have been assigned the individual performance ratings are determined. This is done by summing the scores for each factor. Then each performance ratings are multiplied by its respective weights as percentage. Finally, the results of three factors are added to give a numerical rating for each supplier. [2]

1.2. SUPPLIER SELECTION PROCESS:

Experts agree that no best way exists to evaluate and select suppliers, and thus organizations use a variety of approaches. The overall objective of the supplier evaluation process is to reduce risk and maximize overall value to the purchaser. An organization must select suppliers with which it can do business for an extended period of time. Supplier evaluations often follow a rigorous, structured approach through the use of a survey. An effective supplier survey should have certain characteristics such as comprehensiveness, objectiveness, reliability, flexibility and finally, has to be mathematically straightforward. To ensure that a supplier survey has these characteristics is recommended a step-by-step process when creating this tool. Following steps to follow when developing such a system.

- i) Defining the objectives and selection of criteria for evaluation
- ii) Interviewing the vendors
- iii) Selection of method.

1.2.1. Defining the objectives and selection of criteria for evaluation:

One of the first steps when developing a supplier survey is for the purchaser to decide which performance categories to include. The primary criteria are cost/price, quality and delivery, which are generally the most obvious and most critical areas that affect the buyer. For many items, these three performance areas would be enough, however for critical items needing an in-depth analysis of the supplier’s capabilities, a more detailed supplier evaluation study is required.

Like in the manufacturing and the business sectors, source selection processes in the construction industry also require an impartial, equitable and comprehensive evaluation of the competing proposals and related capabilities using both subjective and objective assessments. This process requires expertise and experience and the use of such ‘expert’ resources are dependent on the complexity of the ‘selected’ procurement route itself.

In general, the source selection process involves two generic tasks such as evaluation of competitors’ (e.g. contractors) competencies (in a prequalification or post-qualification exercise) and evaluation of their tenders/proposals/quotations.

In this study prequalification criteria for supplier evaluation is carried out. This criteria is decided by studying various research papers, interviewing the project promoters.

- 1) Quality of product,
- 2) Past experience
- 3) Past performance
- 4) Finance
- 5) Human resource
- 6) Equipment capabilities
- 7) Price
- 8) Capacity to supply
- 9) Maintaining relations
- 10) Location of site
- 11) Delivery at a time
- 12) Technical capabilities

1.2.2. Interview of vendors:

For each criteria each vendor is interviewed personally. gap analysis between buyers requirement and there supply is examined .It is very important in aspect of scoring of supplier.

1.2.3. Selection of method:

Many previous studies on supplier selection and evaluation defined numerous evaluation criteria and selection framework for supplier selection .There are many methods for multi-criteria decision making approaches studied in previous papers.. Their studies summarized decision methods used for pre-qualifying suitable suppliers, including categorical methods, EDA, cluster analysis, and case-based reasoning systems. Decision models for the final choice phase comprehended the linear weighting, total cost of ownership, mathematical programming, and statistical and artificial intelligence-based models, as illustrated in Fig. 1.[12]

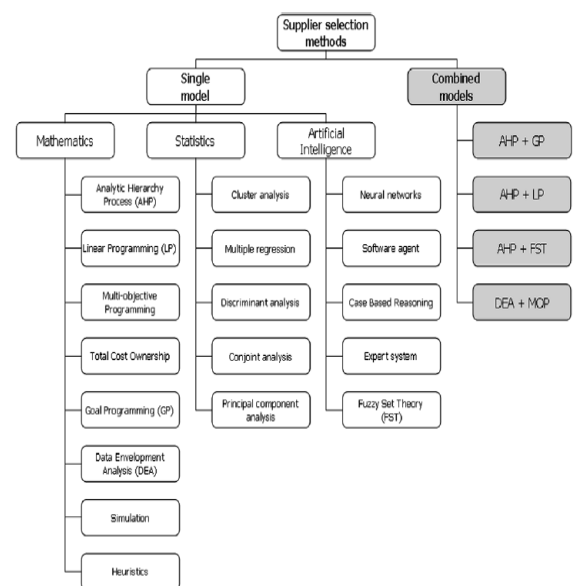


Fig 1.Existing analytical methods for supplier selection

Mathematical programming:

I) Analytical hierarchy process:

The Analytical Hierarchy Process or AHP was first developed by Professor Thomas L. Saaty in the 1970’s and since that time has received wide application in a variety of areas. The Analytic Hierarchy Process (AHP) is a multi-criteria decisionmaking approach and was introduced by Saaty .The AHP has attracted the interest of many researchers mainly due to the nice

mathematical properties of the method and the fact that the required input data are rather easy to obtain. The AHP is a decision support tool which can be used to solve complex decision problems. It uses a multi-level hierarchical structure of objectives, criteria, sub criteria, and alternatives. The data are derived by using a set of pair wise comparisons. These comparisons are used to obtain the weights of importance of the decision criteria, and the relative performance measures of the alternatives in terms of each individual decision criterion. If the comparisons are not perfectly consistent, then it provides a mechanism for improving consistency.

ii) Pre-emptive Goal Programming:

Wang, Huang, and Dismukes (2004) developed an integrated AHP and pre-emptive goal programming (PGP) methodology to take into account both qualitative and quantitative factors in supplier selection. While the AHP process matched product characteristics with supplier characteristics in order to qualitatively determine supply chain strategy, PGP mathematically determined the optimal order quantity from the chosen suppliers.

iii) Linear programming:

Ghodsypour and O'Brien (1998) proposed an integration of an AHP and linear programming to consider both tangible and intangible factors in choosing the best suppliers and giving them optimal order quantities so that the total purchasing value is maximized.

iv) Multi objective programming:

Weber, Current, and Desai (2000) combined a multi-objective programming (MOP) and DEA method to provide buyers with a tool for negotiating with vendors that were not selected right away, as well as to evaluate potential suppliers

2.0. Research methodology :

In case study analytical hierarchy approach selected from study of various research papers. Primary criteria for evaluation is selected by interviewing the project promoters, and various research papers. This criteria is evaluated in mathematical programming modeling named as analytical hierarchy approach. By interviewing each vendor on given attributes pair wise comparison are formed, that pair wise matrix resolve by using AHP.

The criteria is decided by studying various research papers, interviewing the project promoters and it is introduced in questionnaire. The development of questionnaire such as it gives us quantitative results for logical pair wise comparison among the 15 cement and steel suppliers. This questionnaire developed such as it explore the following criteria / attributes:

- 1) Quality of product
- 2) Past performance/experience
- 3) Financial situation of supplier
- 4) Human resource availability
- 5) Equipment capabilities
- 6) Price
- 7) Capacity to supply
- 8) Maintaining relations
- 9) Location of site
- 10) Delivery at a time

By interviewing the 15 steel and cement supplier on given attributes in questionnaire gives us the quantitative results which is useful for pair wise comparisons in AHP. Thoms saaty 1980 gives guideline for Logical sequence in pair wise comparison. AHP model of given attributes resolved in computer program Microsoft excel. Consistency of pair wise comparison is checked in AHP. From this results best supplier among 15 supplier can be chosen for given attributes.

Following are the example of analytical hierarchy process model and its working .

Application of Analytical Hierarchy process (AHP) Introduction

An AHP is a structured technique for dealing with complex decisions. It helps decision makers to find out which is the best suitable vendor of their needs. It aims at quantifying the relative priorities for the given set of the alternatives on the ratio scale, based on judgment of decision makers and stresses the importance of initiative judgment of decision maker as well as consistency of the comparison of alternative decision making process.

AHP process:

- a) Define the problem and determine the goal
- b) Structure the hierarchy from the top (objective makers viewpoint) through intermediate levels to lowest level.
- c) Construct set of prior wise comparison matrix (size $m \times n$) for the each of lowest levels with one of

matrix for each element in the level immediately above by using relative scale measurement. The pair wise comparison is done in terms of which element dominates the other.

- d) There are (n-1) judgments required to develop the set of matrix in step 3. Reciprocals are automatically assigned in each pair wise comparison.
- e) Hierarchical synthesis is now used to weight the eigenvectors by the criteria and the sum is taken over all weighted eigenvector entries corresponding to those in next lower level of hierarchy.

Having made a pair wise comparison the consistency is determined by using the eigen value, λ (lamda) max, to calculate the consistency index CI as follows $CI = (\lambda - n) / (n - 1)$ where n is the size of matrix.

- f) Judgment consistency is checked by taking the consistency ratio of CI with the appropriate value. CR is acceptable, if it doesn't exceed 0.2. If it is more the judgment is inconsistent.

There are 3 vendors S1, S2 &S3 whose consistency is evaluated based on the parameters nearness to site (A), any time delivery experience (B) and past experience of defect rate(C).

Find out the best vendor out of it?

The comparative tables are given below

Attributes	A	B	C
A	1	5	6
B	1/5	1	4
C	1/6	1/4	1

Indicates A is 5 times more preferred than B, A is 6 times more preferred than C

i) Nearness to site

Vendors	S1	S2	S3
S1	1	3	4
S2	1/3	1	1/4
S3	1/4	1/2	1

ii) On time delivery experience

Vendors	S1	S2	S3
S1	1	1/3	1/5
S2	3	1	3
S3	5	1/3	1

Past experience of the defect rate

Vendors	S1	S2	S3
S1	1	5	4
S2	1/5	1	1/4
S3	1/4	4	1

Soln:

Weightage to the attributes

Vendors	A	B	C	P vector Avg of A,B,C
A	1/1.36	5/6.25	6/11	0.691
B	(1/5)/1.36	1/6.25	4/11	0.223
C	(1/6)/1.36	(1/4)/6.25	1/11	0.084
Total	1.36	6.25	11	

Indicates A is 5 times better than B, A is 6 times better than C

i) Nearness to site

Vendors	S1	S2	S3	P vector
S1	1	3	4	0.621
S2	1/3	1	1/4	0.238
S3	1/4	1/2	1	0.137

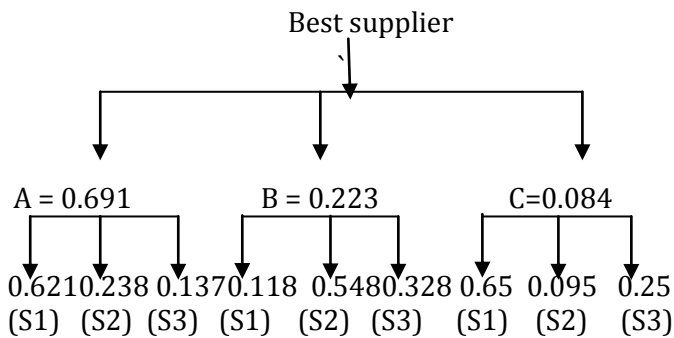
ii) On time delivery

Vendors	S1	S2	S3	P Vector
S1	1	1/3	1/5	0.118
S2	3	1	3	0.548
S3	5	1/3	1	0.328

iii) Past experience of the defect rate

Vendors	A	B	C	P Vector
A	1	5	4	0.65
B	1/5	1	1/4	0.095
C	1/4	4	1	0.254

Hence the best supplier is obtained by



$$S1 = (0.621 \times 0.619) + (0.118 \times 0.223) + (0.650 \times 0.084) = 0.465$$

$$S2 = (0.238 \times 0.619) + (0.548 \times 0.223) + (0.095 \times 0.084) = 0.277$$

$$S3 = (0.137 \times 0.619) + (0.328 \times 0.223) + (0.254 \times 0.084) = 0.179$$

As,

$$S1 = 0.456$$

$$S2 = 0.277$$

$$S3 = 0.179$$

S1 is the most weighted one to be the supplier. Hence he should be given the job.

3. CONCLUSIONS

Experts agree that no best way exists to evaluate and select suppliers, and thus organizations use a variety of approaches. The overall objective of the supplier evaluation process is to reduce risk and maximize overall value to the purchaser. In this paper supplier evaluation system is explored. This paper studied various existing supplier selection methods. In given case study 15 cement and steel supplier were interviewed.

Analytical Hierarchy process is selected for evaluation and selection of best supplier among the 15 suppliers. From above case study it is seen that AHP is used for complex decision rather than correct decision.

AHP can be Programmable in Computer so it is simple to use for multi-criteria decision system.

But pitfall of this AHP seen that this method is depend upon human perception and can disorts pair wise

comparison. Another pitfall of AHP method is it can evaluate consistency of pair wise comparison limited to 39 suppliers only.

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BIOGRAPHIES



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