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Building A Proposed Model For Suppliers' Selection Using Multi-Criteria Approach

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Abstract—*This study aimed to build a proposed model for suppliers' selection using Multi-Criteria Decision Making Approach (MCDMA): The Analytic Hierarchy Process (AHP)" [4] [5] and to apply it in the public shareholding construction companies in Nashik, based on suppliers' competitive priorities "quality, cost, delivery, and flexibility". The study also aimed to evaluate the relative importance of suppliers selection core-criteria, "quality, cost, delivery, and flexibility" from the perspective of functional managers of the researched construction companies. To gather the necessary data a random sample of (50) functional managers have been selected to fill the comparison forms, After analyzing data and applying, the study revealed that which is the most important supplier's selection criterion among all competitive priorities, with a relative index value , cost importance of suppliers' selection, delivery and flexibility respectively. The study revealed also that the use of AHP for suppliers' selection process is highly recommended in the construction manufacturing sector in particular, and other manufacturing sectors. Due to the advantages of this approach in solving complex multi-criteria problems. 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. In this activity material and their procurement is important parameter. About 60-70% cost engaged in construction are for material itself. Material procurement is prior important step of purchase action. Wider range of supply activity included in procurement process as compared to purchasing action. Vendor is important aspect in procurement process.*

In this highly competitive environment, 'Supplier' is one of the most important components of a supply chain. At present most of the construction companies are randomly selecting suppliers for the purchase of materials. It also lacks on part of considering the relative importance of criteria while making a selection of the best supplier. This study is a supplier evaluation approach through the Analytic Hierarchy Process. Such approach may support supplier selection in the most scientific manner which considers the relative importance of various criteria for decision making. 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 Supplier Evaluation and Management is a very strong concept in manufacturing industry, but has to come a long way in the construction Projects.

Keywords—MCDMA, AHP, Suppliers, Vendors, Nashik.

1. INTRODUCTION

Decision making can be regarded as the cognitive process resulting in the selection of a belief or a course of action among several alternative possibilities. It is the process of identifying and choosing alternatives based on the values and preferences of decision maker. People often find it hard to make decisions in a complex, subjective situation with more than a few realistic options. So what we need is a systematic and organized way to evaluate our choices and figure out which one offers the best solution to our problem. The Analytic Hierarchy Process method is one of the best methodologies based on analytic hierarchy process to solve the decision making problems. It enables multiple decision makers on evaluation and uses triangular fuzzy scale. By considering the market opportunities in Nashik city, the challenge is to know the answer of this question from the customer's point of view. Therefore understanding of various factors that influence the buyer behavior is the significant source to the promoters.

Suppliers have been acknowledged as the best intangible assets of any business organization However, selecting the right sup- pliers for a long term relationship is a relevant procurement is- sue that demands judicious attention. The supplier selection problem has become one of the most important issues for establishing an effective supply chain system. Indeed, supplier selection and evaluation represents one of the significant roles of purchasing and supply management functions. One of the key elements essential to supply chain success is an effective purchasing function. The purchasing function of a construction firm is central to materials management and especially includes the commitment of project funds for construction materials. Purchasing within an organization typically involves all activities associated

with the buying process. These activities include: determining the need, selecting the supplier, arriving at a proper price, specifying terms and conditions, issuing the contract or order, and ensuring proper delivery. The step involving supplier selection is one of the most significant steps in the building construction process. Past literature and anecdotal evidence suggest that the main issue with materials purchasing is with supplier selection in the building materials industry, which depends on careful examination of supplier economics.
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. Supplier Evaluation and Management 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. Study will ensure that customer will be more satisfied. Study puts efforts in effectiveness in selection of vendors and their evaluation).

Researchers agreed on the increasing importance of the suppliers and sources of supply for organizations and supply chains. Asamoah, et al (2012) attributed to that procurement of goods and services are the most expensive part, and it accounts for 70% of the total cost of production process. This explain the importance of strong supplier partnership between organization and their suppliers, as it grants the organization a range of benefits, on the top of them the ability of organization to get the appropriate quality of inputs at a reasonable price, with the right quantity, at the right time on the right place. This makes it imperative for organization to find an approach to evaluate those suppliers and select the best of them to be their partners in the supply chain. Glomohmad (2007) debated that the Analytical Hierarchy Process (AHP) is one of the most important techniques used in the process of making decisions of evaluating and selecting suppliers, it provides a practical frame work to solve a lot of problems, one of the entrance of Multi Criteria Decision Making (MCDM), standards that enables the decision maker to solve complex problems by simplifying these in evaluation and selection of suppliers from time to time and from industry to another. There are a number of managerial decisions that create and regulate the supply chain and are embedded in the process for materials management. The main question arising and is worth researching is how can we develop a supplier management approach that will be based on supplier's environmental performance in order to assist managers and decision makers set and prioritize sustainability-related actions with regard to their suppliers. This chapter provides a more thorough description of the problem under study followed by the conceptual and technical research design of this research.

2. PROBLEM STATEMENT

In reality a lot of organizations are choosing suppliers based on price only, the best supplier for those organizations is the least expensive. Other organizations are using additional criteria such as production capacity, quality and reputation of supplier. After meeting procurement managers of construction companies and revising their purchase policies, the researcher noticed that the subject of supplier selection is assigned to special comities and commissions in these companies, and that they use individual standards such as lowest price, knowledge, and reputation in suppliers prioritizing, which means that personal subjective judgment still play a great role in determination of the appropriate supplier, this presents the importance of using objective standards and techniques to select best suppliers. In line with the objective of this research in trying to resolve this issue through building& applying a scientific model for supplier selection.

3. SCOPE OF THE WORK

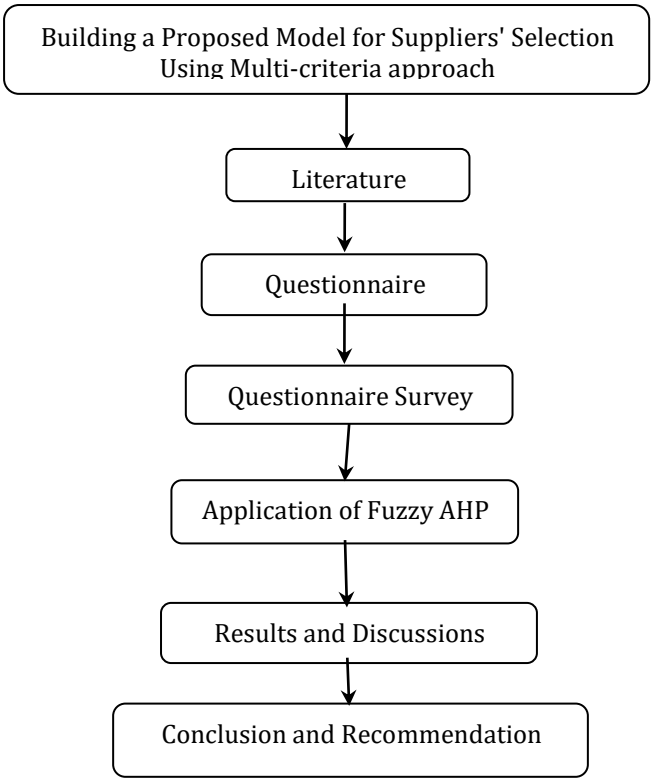
The scope of work is to provide an integrated approach, particularly for organizations where the complexity of the supply chain is high, as to how to prioritize and customize their efforts and resources towards engaging their suppliers in the improvement of their products.

4. OBJECTIVES

1. To explore & develop the factors that antecedents of suppliers and sources of supply for organizations and supply chains
2. To examine relationship between factors consider for suppliers and sources of supply for organizations and supply chains and customers buying attitudes in construction industries.
3. A supplier selection by systematically analyze the trade-off between conflicting criteria.

5. METHODOLOGY

A survey will be conducted to collect a data from managers. To gather the required data to build the proposed model for supplier selection, a simple random sample of 50 functional managers, has been selected. each manager was asked to fill complete set of forms (each set include 15forms) scaled form of (1-9) to determine the degree of importance of one element on another element of the three comparison levels of the hierarchy: core-criteria of competitive priorities, sub-criteria of each priority, and alternative suppliers in order to form the pair comparison of relative importance matrix of all levels of pyramid.



6. A FUZZY NUMBER

A fuzzy number is a quantity whose value is imprecise, rather than exact as is the case with "ordinary" (single-valued) numbers. Any fuzzy number can be thought of as a function whose domain is a specified set (usually the set of real numbers, and whose range is the span of non-negative real numbers between, and including, 0 and 1000. Each numerical value in the domain is assigned a specific "grade of membership" where 0 represents the smallest possible grade, and 1000 is the largest possible grade. In many respects, fuzzy numbers depict the physical world more realistically than single-valued numbers. Suppose, for example, that you are driving along a highway where the speed limit is 55 miles an hour (mph). You try to hold your speed at exactly 55 mph, but your car lacks "cruise control," so your speed varies from moment to moment. If you graph your instantaneous speed over a period of several minutes and then plot the result in rectangular coordinates, you will get a function that looks like one of the curves shown below. [19]

The red curve (top) represents a triangular fuzzy number; the blue curve (middle) shows a trapezoidal fuzzy number; the green curve (bottom) illustrates a bell-shaped fuzzy number. These three functions, known as membership functions, are all convex (the grade starts at zero, rises to a maximum, and then declines to zero again as the domain increases).

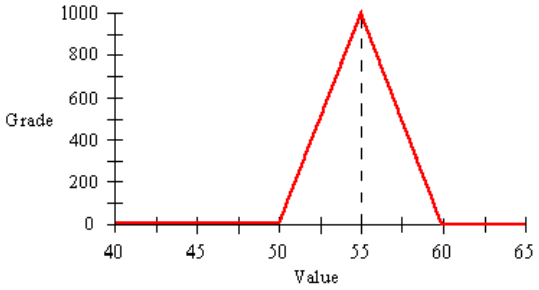


Fig. No. 1 Triangular Fuzzy Number

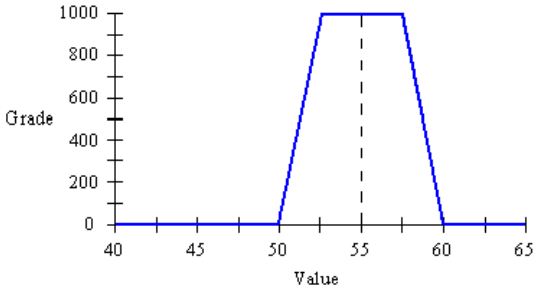


Fig. No. 2 Trapezoidal Fuzzy Number

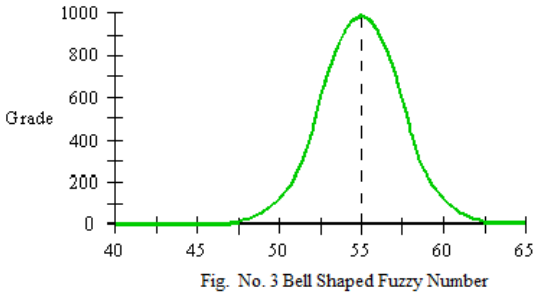


Fig. No. 3 Bell Shaped Fuzzy Number

Figure 1: The Criteria and Area Alternatives

However, some fuzzy numbers have concave, irregular, or even chaotic membership functions. There is no restriction on the shape of the membership curve, as long as each value in the domain corresponds to one and only one grade in the range and the grade is never less than 0 nor more than 1000.Fuzzy numbers are used in statistics, computer programming, engineering (especially communications), and experimental science.

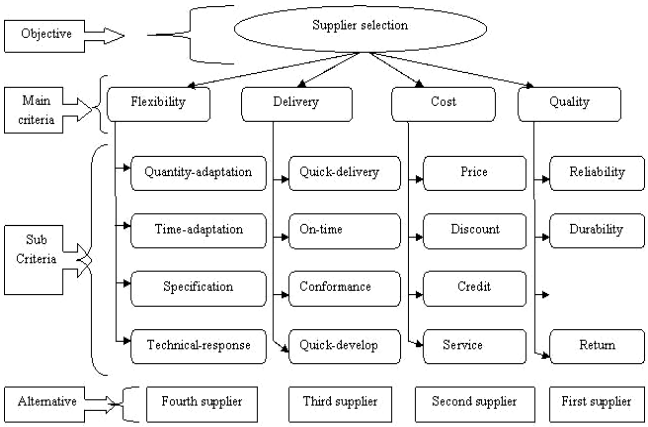
The concept takes into account the fact that all phenomena in the physical universe have a degree of inherent uncertainty.

7. RESULT AND DISCUSSIONS

7.1 Building the Proposed Model for Supplier Selection

Saaty scale	Definition	Fuzzy Triangular Scale
1	Equally important (Eq. Imp.)	(1, 1, 1)
3	Weakly important (W. Imp.)	(2, 3, 4)
5	Fairly important (F. Imp.)	(4, 5, 6)
7	Strongly important (S. Imp.)	(6, 7, 8)
9	Absolutely important (A. Imp.)	(9, 9, 9)
2	The intermittent values between two adjacent scales	(1, 2, 3)
4		(3, 4, 5)
6		(5, 6, 7)
8		(7, 8, 9)

The study utilized a well-known global model for supplier selection called analytical hierarchical process that uses Multi Criteria Decision Making. Saaty (2012) explained that the first step of structuring the general model begin with the definition of the problem and determination of the objective of using the process, the second step is identifying the key-criteria and sub-criteria used in the analytical process to achieve the desired objective, and then to determine the list of possible alternatives to achieve this objective see figure-1[13]



7.2 Determining Weights of Main Criteria (Level 1)

Name of Supplier: Mr. Valmik Kunde
(Sample Calculation):

Table 1: Pair Wise Comparisons of Main Criteria

A. Imp.	F. Imp.	F. Imp.	W. Imp.	Criteria	Eq. Imp.	Criteria	W. Imp.	F. Imp.	F. Imp.	A. Imp.
(9, 9, 9)	(6, 7, 8)	(4, 5, 6)	(2, 3, 4)		(1, 1, 1)		(2, 3, 4)	(4, 5, 6)	(6, 7, 8)	(9, 9, 9)
	✔			Quality		Cost				
	✔			Quality		Delivery				
	✔			Quality		Flexibility				
				Cost		Delivery			✔	
				Cost	✔	Flexibility				
				Delivery	✔	Flexibility				

7.3 Determining Weights of Main Criteria (Level 1)

Table 2: Comparison matrices for main criteria

Criteria's	Quality	Cost	Delivery	Flexibility
Quality	(1, 1, 1)	(6, 7, 8)	(6, 7, 8)	(6, 7, 8)
Cost	(1/8, 1/7, 1/6)	(1, 1, 1)	(1/8, 1/7, 1/6)	(1, 1, 1)
Delivery	(1/8, 1/7, 1/6)	(6, 7, 8)	(1, 1, 1)	(1, 1, 1)
Flexibility	(1/8, 1/7, 1/6)	(1, 1, 1)	(1, 1, 1)	(1, 1, 1)

Quality = $(1x6x6x6)^{1/4}$; $(1x7x7x7)^{1/4}$; $(1x8x8x8)^{1/4}$
= 3.8337; 4.3035; 4.7568
Cost = $(1/8x1x1/8x1)^{1/4}$; $(1/7x1x1/7x1)^{1/4}$; $(1/6x1x1/6x1)^{1/4}$
= 0.3536; 0.3780; 0.4082
Delivery = $(1/8x6x1x1)^{1/4}$; $(1/7x7x1x1)^{1/4}$; $(1/6x8x1x1)^{1/4}$
= 0.9306; 1.0000; 1.0746
Flexibility = $(1/8x1x1x1)^{1/4}$, $(1/7x1x1x1)^{1/4}$,

$(1/6x1x1x1)^{1/4}$
= 0.5946; 0.6148; 0.6389

Table 3: Geometric means of fuzzy comparison values

Criteria's	r_i		
Quality	3.8337	4.3035	4.7568
Cost	0.3536	0.3780	0.4082
Delivery	0.9306	1.0000	0.4082
Flexibility	0.5946	0.6148	0.6389
Total	5.7124	6.2963	6.8786
Reverse (power of -1)	0.1751	0.1588	0.1454
Increasing Order	0.1454	0.1588	0.1751

In the fifth step, the fuzzy weight of criterion is found by using following formula,

wĩ = rĩ * (rĩ1 + rĩ2+ .....rĩn)
= lw, mw, uw

. Hence the relative fuzzy weights of each criterion are given in Table 4.

Table 4: Relative fuzzy weights of each criterion

Criteria's	w_i		
Quality	0.5574	0.6834	0.8329
Cost	0.0514	0.0600	0.0715
Delivery	0.1353	0.1588	0.1882
Flexibility	0.0865	0.0976	0.1119

In the sixth step, the relative non-fuzzy weight of each criterion (Mi) is calculated by taking the average of fuzzy numbers for each criterion. In the seventh step, by using non fuzzy Mi, the normalized weights of each criterion are calculated and tabulated in Table 5.

Table 5: Averaged and normalized relative weights of criteria

Criteria's	M_i	N_i
Quality	0.6912	0.6833
Cost	0.0610	0.0603
Delivery	0.1608	0.1589
Flexibility	0.0987	0.0975

8. CONCLUSION

In this study Fuzzy Analytic Hierarchy Process Method is applied to solve the problem of selecting the best material supplier.

1. This methodology includes simple mathematical calculations, and it yields triangular fuzzy numbers of alternatives' weights.
2. This proposed methodology can handle the problems effectively and with efficiency. It is interesting to observe that the result obtained under the Fuzzy Analytic Hierarchy Process will help customer to choose building in different location of the Nashik city.
3. Depending on various criteria of selection is one of the most important tasks for construction industries point of view. Since most of these criteria conflict each other, the alternative area should be inspected effectively.

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