

Supply Chain Management in Construction Industry

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Abstract: *Construction industry faces a lot of inherent uncertainties and issues. Application of supply chain management philosophy to the construction industry has been widely investigated in recent years as effective and efficient management measure and strategy to improve the performance of construction. Supply chain management (SCM) can be considered as the coordination of distributed decision making of organization on material flow and information flow. Supplier selection is one of the important factors in Supply Chain Management. This paper contains a review on generally used methods and factors for supplier selection by other industries.*

Keywords: Supply chain management, construction industry, supplier selection, coordination

1. Introduction

Supply Chain Management (SCM) is a traditional concept which originates initially in manufacturing industry mainly to control logistics. It is defined as the management of flow of goods and services. It includes the movement and storage of raw material, work in process inventory and finished goods from the point of origin to point of consumption. Supply Chain Management aims to reduce the cost and helps to attain profit for each and every member in supply chain. The members in supply chain consist of all parties which directly or indirectly satisfies the requirements of customer needs. Supply Chain Management concept proved to be successful in other industries thereby this concept can be applied in construction industry.

As far as the construction industry is concerned, purchasing can occur in all the phases of a construction project. One of the important purchasing functions is selecting suppliers capable of procuring the demanded items that meet the required specification. Selecting the right supplier is a key to the procurement process as it has a direct impact on the performance of an organization. Choosing the wrong suppliers can cause financial as well as operational problems. Supplier selection is seen as the important issue for establishing an effective supply chain system. Supply chain management thus aims in the coordination of each party in supply chain so that organization can earn profit by reducing unnecessary cost such as those from delay, claim etc. Selection process for a supplier involves both quantitative and qualitative factors. Since supplier selection is viewed as a Multi Criteria Decision Making problem (MCDM), it is required to be solved by a powerful MCDM technique. These techniques help the decision makers to evaluate a set of alternatives.

2. Research Background and Hypothesis

One of the tedious jobs for any organization is selecting and evaluating continuous improvement of the suppliers. Decision maker has to consider various conflicting factors while choosing a supplier. This study aims in generalizing different criteria and methods used for supplier selection process.

According to **Ondieki et.al** the factor which influences the effectiveness of supply chain management are supplier

relationship, inventory management, information technology, training and distribution. This reveals that lack of supplier relationship management strategies greatly lowers the effectiveness of supply chain management function.^[7] According to **Zohreh et.al** sustainability criteria can be viewed as the most important decisive criteria while selecting suppliers, due to environmental disaster, degradation of raw material and natural resources.^[18] **Paulo et.al** studied application of Analytical Hierarchy Process (AHP) in selected 5 criteria such as quality, financial, synergies, production system and cost^[8]. **Manoj Sharma** proposed a different Multi Attribute Decision Making Technique (MADMT), which can be used for obtaining the best among alternatives^[6]. **Raja Sharma et.al** developed a supplier selection model for the manufacturing industry which is a combination of two techniques namely Analytical Hierarchy Process (AHP) with Supply Chain Operation Reference (SCOR). This method helps to find a solution to the supply chain problem^[10]. **Hepu Deng et.al** studied the comparison of objective weighting methods and found Shannon's entropy measure was best among other objective methods^[3]. **T. Farzad et.al** discussed about various methods in manufacturing industries. It also discussed AHP method with its advantages and disadvantages^[15]. **S.A.H. Manal et.al** focusses on certain criteria used by contractors for supplier selection to reduce expected risk and tried to identify maximum probable risk facing by construction companies^[14]. **Ruben Vrijhoef et.al** discussed the role of supply chain management in construction and it also found the limitations of each roles using empirical and generic theory of supply chain management.^[12] **R.S.Bindu et.al** discussed the applications of relative reliability risk assessment concept for the new suppliers^[11]. **Manish Kumar Sagar et.al** discussed about criteria which can be used for supplier selection in automobile industry^[5]. **Vyas Gayathri S. et.al** discussed about different multi criteria decision making techniques along with its weakness and strength^[17].

3. General Factors and Methods Used for Supplier Selection

The decisions in supply chain management are always subjected to various conflicting criteria or factors. As the need of supplier selection criteria changed the selection method also improvised from time to time. These factors are the general crucial criteria looking by most of the construction company while procuring materials. These

factors were selected by the purchase manager of various reputed company. These criteria have major influence on supplier selection problem.

3.1.1 Price

Price is one of the basic criteria. In order to increase the profitability, every organization tries to minimize the procurement cost. The procured material should have a reasonable price. Most of the firm looks for those suppliers who supply the raw material for the reasonable cost.

3.1.2 Quality

The term quality has wide area of dimensions. Every organization needs good quality products irrespective of price factor. Quality has mainly two components. Quality of conformance, which indicate the quality defined by absence of defects and quality of design which means the quality measured by the degree of customer satisfaction. Whatever be the perspective, every organization has quality as its prime importance.

3.1.3 Delivery time

Delivery time is also having the same importance that of quality. The supplier should supply the materials as per the schedule. If he fails to do so it became a great loss for the organization as well as for the client. Lead time is the term refers to the time period between order and actual delivery. As the lead time reduces, those suppliers will be the best for that organization.

3.1.4 Management

The management of supplier is also one of the factors which a construction company looks at the time of procurement of material. Financial performance, achievement in sales etc. are the major dimensions for measuring this. Good supplier should have high organizational and coordination skill in order to meet the requirements of a firm.

3.1.5 Repair service

The term repair service has a considerable importance given by most of the purchase managers. Buyer always favors those suppliers who offer better client service after the sale. Good service provided by suppliers may help to increase the trust in them by client and the company.

3.1.6 Geographical Location

Purchaser always prefers those suppliers who are near to their company or work site so that cost for the transportation can be minimized. The purchaser will consider the home place of supplier, location of plant etc. before selecting and awarding the contract. Otherwise it may affect the long term relationship. Most of the companies will come to an understanding regarding transportation cost, such expenses at the time of negotiation.

3.1.7 Technical Capability

While supplying materials the supplier should have a basic idea about the nature of material. Supplier should introduce new material or products quickly in this fast moving competitive world. Such new materials become an important asset for any organization. So supplier should have competent technical ability in order to introduce high quality product and services, which promote successful development efforts and to ensure improvements in future performance.

3.1.8 Financial Position

In a partnership venture, every buyer will look for a supplier who has a financially stable footing. For a supplier of stable financial base is preferred by most of the organization because if any delay payments happened the supply will not be hindered.

3.1.9 Proper Communication

In order to avoid conflicts it is necessary to ensure proper communication between supplier and purchaser. Good suppliers should make an effort to communicate effectively with an organization. They should update or keep in touch with each other till the end of the project. Through effective communication organization and supplier can make profits out of their work.

3.1.10 Customer satisfaction

The factor customer satisfaction has equal importance along with the quality, delivery time and price. Customers are the back bone of any organization. The performance of supplier is measured from the response of customers towards the products and services delivered. A supplier who has good customer base is mostly preferred by any organization than others.

3.1.11 Reliability

Buyers always prefer the suppliers who are reliable to them. Every firm expects that the selected supplier should deliver the service or materials exactly what they require. The supplier should be consistent with every timing and quality issues.

3.1.12 Long Term Relationship

Long term relationship is very important for any partnership venture. The members of supply chain should maintain the positive relationship till the completion of project. Success of any organization requires the effective and sustainable relationship. Buyer organizations as well as supplier organization always look for win-win relationship.

3.1.13 Honesty

Honesty or in other words trust is an important factor which should occur from both the organization. It is an essential factor to maintain long term relationship among supplier and buyer organization. It is defined as a person's reputation for trustworthiness on both professional and personnel level as well as credibility in business situation.

3.1.14 Testing certification

This plays a major role in quality factor. Supplier should follow the quality standards for the materials delivered. They should ensure the quality of products or material by conducting standard tests before supplying to any construction firm. They should submit the evidence of this quality measurement along with the materials.

3.1.15 Commitment

Commitment towards the undertaken works by supplier is essential to build a long lasting relationship with any purchasing organization.

3.1.16 Discounts

Purchaser always tries to minimize the cost of procurement. Providing the discounts is one of the attracting factors. The purchaser expects a reduction in price if bulk amount of material or product is procured from any supplier.

3.1.17 Safety and Health Considerations

Supplier should stick on to safety and health practices in order to avoid any industrial oriented accidents. They should give considerable care to the workers who are using their products. They should not deliver products which can cause harm to the labours. They should supply safety manuals or precautions along with their delivered products. They should not supply those materials which can cause harm to the environment.

3.1.18 Payment terms

It is also important factor while developing a long term relationship in business. In a fixed price contract, the price term specifies what the supplier will be paid regardless of the actual cost. In cost plus contract, formula is specified that determines how much the supplier will be paid.

3.2 Methods used for supplier selection

Different methods are using to solve supplier selection problem by other industries. Traditional methods are considered as appraisal method. Table 3 shows some of the methods generally used for supplier selection by other industries. Among these methods, Multi Criteria Decision Making methods are viewed as effective one since these methods can handle multi criteria.

3.2.1 Categorical method

The categorical method involves categorizing each supplier's performance in specific areas defined by a list of various 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 term such as good, neutral and unsatisfactory. This is a very simple and inexpensive method. Its quality heavily depends on the experience and ability of the buyer to judge the situation. It is not precise. The degree of subjectivity judgment is very high.

3.2.2 Weighted Point Method

In weighted point method, the buyer has to specify the value of one performance measure relative to another. Then the weights for each attribute are multiplied by the performance score that is assigned. This is useful for the quantitative measures. It is difficult to take effectively qualitative factors into consideration. But it can overcome the subjectivity of categorical system.

3.3.3 Analytical Hierarchical process

Analytical Hierarchical Process (AHP) is a decision making method for selecting best among the alternatives. This method is developed by Thomas. L. Saaty in 1970's, which was developed based on mathematics and human psychology. It considers multi criteria and it provides decision maker to convert the complex problem in the form of a hierarchy. Hierarchy has mainly three levels- the goal, the criteria and alternatives. For a supplier selection problem, the goal is to choose best supplier. The criteria can be price, quality etc. and alternatives means the proposal supplied by suppliers. This method compares alternatives with each criteria and then determines overall ranking for the alternatives.

3.3.4 Analytical Network Process.

Analytical Network Process (ANP) shows by a network that has clusters of elements than a hierarchy. ANP considers outer dependence (interaction and dependence between clusters), inner dependence (interaction and dependence between elements in a same cluster), and feedback. This method is widely used by the decision makers. It includes network with dependence and feedback, instead of hierarchy form.

3.3.5 Technique for Order Preference by Similarity to Ideal Solution (TOPSIS)

Technique for Order Preference by Similarity to Ideal Solution is one of the multi criteria decision making techniques developed by Hwang and Yoon. This method is based on the principle that the chosen alternative should have the shortest distance from the Positive Ideal Solution (PIS) and the farthest distance from the Negative Ideal Solution (NIS). The Positive Ideal Solution maximizes the benefit criteria and minimizes the cost criteria, whereas the Negative Ideal Solution maximizes the cost criteria and minimizes the benefit criteria. TOPSIS is mainly used to solve the complex selection problems since it involves simple mathematical calculations.

3.3.6 Linear Programming.

Linear programming is a method to achieve the best outcome in a mathematical model whose requirements are represented by linear relationship. It is a special case of mathematical programming. Linear programming can be applied in various fields of study such as business, economics and to some engineering problems like supplier selection.

3.3.7 Goal Programming.

Goal programming is a branch of multi objective optimization which in turn is a branch of multi criteria decision analysis. This is an optimization programme which

can be used for extension or generalization of linear programming to handle multiple conflicting objective measures.

3.3.8 Multi Objective Programming

Multi Objective programming is also known as vector optimization, multi criteria optimization. It is an area of multiple criteria decision making that is concerned with mathematical optimization problems involving more than one objective function to be optimized simultaneously. It can be applied in numerous fields where optimum decisions need to be taken in presence of tradeoff between two or more conflicting objectives.

3.3.9 Case based reasoning (CBR)

Case Based Reasoning (CBR) is the process of solving new problems based on the solutions of similar past problems. CBR is not only a powerful method for computer reasoning but also a pervasive method for solving radical human problems.

3.3.10 Artificial Neural Network (ANN)

Artificial Neural Network are generally presented as systems of inter connected neurons which exchange messages between each other. The connections have numeric weights hat can be tuned based on experience, making neural nets adaptive to inputs capable of learning. ANN types vary from those with only one or two layers of single direction logic, to complicated multi input many directional feedback loops and layers.

	Theory (MAUT)	international supplier selection.
9.	Case Based Reasoning	• Purely an artificial intelligence approach.
10.	Artificial Neural Network (ANN)	• Saves time, money • Requires sophisticated software.

4. Conclusion

Supplier selection model developed for other industries is found to be successful with industry specific criteria. Supplier selection for the construction industry is very time consuming and hectic job. There arises a need for suitable supplier selection model which makes the purchasing function smooth. This review aims to generalize the various criteria and methods that can be implemented for developing a supplier selection model in construction industry.

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Table 3: Methods used for supplier selection

Sl.No:	Methods for supplier selection	Salient feature of method
1.	Categorical method	<ul style="list-style-type: none"> • Simplest, quickest, easiest and least cost to implement. • Based on historical data and buyer's experience.
2.	Weighted Point Method	<ul style="list-style-type: none"> • Easy to implement • Flexible and much more objective. • Costlier than categorical method.
3.	Linear Programming Techniques	<ul style="list-style-type: none"> • According to the defined criteria by the purchaser.
4.	Goal Programming	<ul style="list-style-type: none"> • Based on the target required by the client.
5.	Analytical Hierarchical Process (AHP)	<ul style="list-style-type: none"> • Developed for prioritizing alternatives when multiple criteria are considered. • Its implementation is quite inconvenient.
6.	Analytical Network Process(ANP)	<ul style="list-style-type: none"> • Considers qualitative behavior along with quantitative factors.
Sl. No:	Methods for supplier selection	Salient feature of method
7.	Technique for Order Preference by Similarity to Ideal Solution (TOPSIS)	<ul style="list-style-type: none"> • It uses idea of distance based decision making. • Calculates maximum distance from -ve solution and minimum distance from +ve solution.
8.	Multi Attribute Utility	<ul style="list-style-type: none"> • Mainly in case of

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