

Criteria Requirement for IBS Vendor Selection

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Abstract— Decision making of vendor selection in construction procurement has been addressed as a crucial process not only in conventional construction project, but also in Industrialised Building System (IBS) project. The existence of high number of vendor and criteria, and the fragmentation of construction process have increased the difficulties of construction vendor selection process. This situation created a decision making dilemma for construction companies to select the right IBS vendor that fulfils the project needs. Thus, a decision making tool is recommend for this purpose. This paper discusses a decision making technique called Multi Attributes Decision Making (MADM) and set of criteria used in literature for construction vendor selection. As an initial step to develop a decision model, past studies were analysed to gather the related IBS vendor selection criteria. It is identified that the selection criteria can be categorize into cost, quality, service, buyer and vendor relationship, assurance supply, payment term, and past performance. Based on our frequency analysis, 38 criteria were found related with IBS vendor selection. This outcome yield from this paper is essential to develop research instrument for decision model of IBS vendor selection in the next phase of our research.

Keywords— *Industrialised building system (IBS), criteria, vendor selection, multi attributes decision making (MADM).*

1. Introduction

The role of purchasing in supply management is not a new phenomenon yet still received much attention and becoming more abroad as the years goes by. In 21st century business environment, an effective purchasing approach has been addressed as strategic approach in supplier management to achieve business objective and also to fulfil

organisation needs in future [1]. Purchasing is a part of supplier chain which consists of activities such as vendor identification, vendor selection, buying, negotiation and contracting, vendor market research, supplier measurement and improvement [1].

Proper selection of vendor is the foundation of an effective decision process in purchasing [2]. Several of past studies have been investigated the benefits of proper vendor selection in numerous of fields including construction industry. For example, an international survey of 360 major companies within eight industries has been carried out by [3]. The study has revealed four benefits of effective vendor selection such as increase profitability, increase quality, and decrease cost. In addition, an intensive literature review study has concluded there is positive relationship between purchasing activities such as vendor selection with overall company performance [4]. An effective vendor selection also play significant role in reducing total cost of material and increasing quality of product [1]. Material cost reduction is importance in business. This is due to most of the company spend half of their total revenues on materials and component cost. Based on case study in Iran, a decision making in vendor selection is not only reducing cost of material, but also increase corporate competitiveness [3]. The summaries of benefits in vendor selection evaluation are;

- Increase profitability [3], [5]
- Increase Quality [1], [3]
- Increase overall performance [4]
- Increase cooperative competitiveness [2], [5]

Thus, numerous of studies in effective purchasing supplier management has been carried out in numerous of field including construction industry [2], [4]. Vendor selection is a crucial process in

construction procurement during early phase of project life cycle. Project procurement is referring to the purchasing process that consists of activities such as vendor identification, vendor selection, buying, negotiation and contracting, vendor market research, vendor measurement and improvement [1]. Vendor selection in procurement of the project play significant role in order to decrease project risk (such as delay, overrun cost and low quality of project outcomes), ensure the availability of project material and minimizing project cost [6]–[8]. Figure 1 below illustrates the significant of activities such as procurement process in early phase of construction project life cycle.

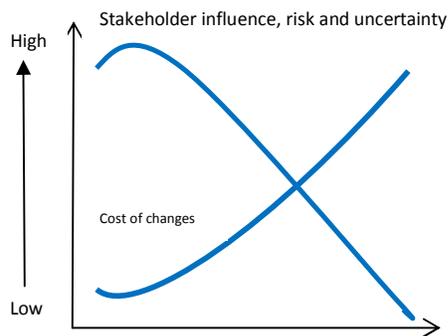


Figure 1. Degree of risk through project time [43]

Figure 1 shown, any decision process of early phase in project consist of high risk and uncertainty. Therefore, the decision making of vendor selection in construction has been considered as one of determine factor of project successful. In comparison with other industry, vendor selection in construction has been found more complex due to several of reasons such as involve multiple of stakeholder, and fragmentation process [8]. Supply chain in construction industry also involved wide range of component part with different requirement based on variety of project [5]. Other authors also have highlighted the involvement of large number of key participant such as client, consultant, contractor and several of vendor in one project has increase the complexities in construction vendor selection [9], [42]. Moreover, the influence of vendor selection in construction is more dominant due to construction material occupies an essential part of construction value contributing almost 50%. This percentage is increase in IBS construction project where most of the project components are prefabrication material

[10]. Thus, any disturbance of supply chain relationship in IBS can led to several major problems in construction such as project time delay and overran cost [11], [44]. The wide number of vendor in construction industry has also increase the complexity of the vendor selection process. In term of IBS, the number of vendor in IBS is also increase. Report have shown numbers vendor were available on market in 2010, which consist of 36 precast concrete framing, panel and box system, 16 steel framework system, 29 steel framing, 16 prefabricated timber framing system, 10 block work system and 11 other IBS method such as on site manufacturing [12]. These number were continue increasing in year 2011 with 104 precast concrete framing, panel and box system, 79 steel formworks system, 32 steel framing system, 25 prefabricated timber framing system, 14 blockwork system, 35 on site manufacturing system and 16 other innovative solution system. Thus, there arises a need for suitable vendor selection model in IBS construction which can enhance the decision process. In addition, decision makers in construction vendor selection are tend to make several of following mistakes [13];

- Lack proficiency at identifying the capabilities of their suppliers
- Base materials vendor decisions on convenience
- Delay the assessment of the value added by suppliers and service providers
- Fail to recognize the impact of economic changers on bulk materials prices

Furthermore, availability of numerous construction vendor selection criteria also has been increase the difficulty of the decision process. In the last decades, there has been a growing body of literature in construction vendor selection criteria [29] [35] [36] [37] [38]. Literature has illustrates there are some criteria may be common across construction project, however, some criteria are likely to be unique depend on the company and project needs. Thus, figure 2 present the overall factor of decision aid in construction vendor selection. Therefore, due to these aforementioned issues, this paper introduces MADM method as potential decision aid for IBS vendor selection. As a part of decision model development, this paper also discussed the availability of criteria that related to IBS vendor selection.

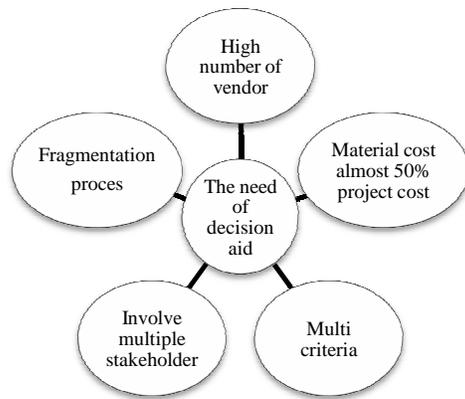


Figure 2. The need of decision aid in construction vendor selection

2. MADM in Vendor Selection Problem

The title of the MADM has been defined as a decision technique that allows decision makers to determine the best alternative through evaluation and comparison process between the alternative [14], [15]. Research has shown extensive evidences of implementation of MADM as an solution for vendor selection problem in various of fields such as manufacturing [16], communication [17], electronic [18], textile [19], automobile [20], and including construction field [21]. According to literature review study by [22], most of MADM techniques mainly covered AHP, ANP, DEA, TOPSIS, VIKOR, Goal Programming, and linear programing [22]. In order to provide more reliable, effective and simple MADM method, the investigation and research on classical MADM is keep continues. For example, MADM method has been criticizes due to rank reversal problem where rank of existence alternatives may change due to the introduction of new alternative. However, this limitation can be avoided by selection of normalization method [23].

Classical MADM method also has been labelled was not inadequate to represent a real world problem due to the used of crisp value [34]. Thus, to deal with this limitation, an integration of MADM method and Fuzzy set has been carried out. Modelling using fuzzy sets is proven to be an effective way for formulating decision problems where the information available is subjective and imprecise [24]. In addition, past researchers have also proposed an integration of MADM technique such as TOPSIS and DEA [36], AHP and Fuzzy

TOPSIS [20], and Fuzzy AHP and DEA [25] in vendor selection problem. In recent years, researchers in construction are moving forwards to utilize MADM as a solution in selection problem particularly in vendor selection. For example, an implemented AHP for a real case of construction company in Turkey and presented with sensitive analysis to select the best vendor [26].

Ref. [7] has developed an integrated construction material management (ICMM) model by development of virtual inventory management, feasible material management network and a vendor selection process. Vendor selection process in their model was developed based on TOPSIS and demonstrated with real construction project. Ref. [21] has proposed a new decision support model that based on SMARTER method for civil construction company in Brazil. This model has been applied to real construction project and has been proven capable to encourage a high collaboration among project stakeholders.

These studies proven that MADM is an effective tool for vendor selection type of problem in construction field. However, in literature there is limited study attempt to thoroughly investigate decision process to select the right vendor in IBS construction project. Only Ref. [27] has proposed AHP method for IBS material vendor selection without considering integration of MADM method and Fuzzy set. Thus, due to the absent of decision technique, it is desire to develop an effective integration multi criteria decision technique for IBS vendor selection.

Most of the effectiveness of MADM methods is influence by the selection criteria. Thus, identification of suitable vendor selection criteria is crucial towards transparent vendor selection process in construction industry. However, there are tremendous of criteria has been proposed in past. With high business competitive environment, the traditional single criterion such as lowest cost is no longer relevant in selection of appropriate vendor [28]. The involvement of criteria such as delivery, quality, production facilities and capacity, technical capability, geographical location, management, reputation and position in industry and, financial position are turned to be more important [29].

3. Vendor Selection Criteria in Construction

Research on vendor selection has started since 1966, and yet still continues gaining attention from researchers till now [29] [30] [31] [33]. The choice of the right vendor is complex decision with involvement of wide criteria. Ref. [28], have explained that classical single criterion such as lowest cost is no longer relevant with competitive business environment. Ref. [30] is the early study who has introduced 23 criteria from his survey among 300 purchasing managers. He has addressed, instead of lowest price, quality is the most crucial criterion followed by delivery and performance history. Ref. [31] has performed an analysis on Ref [30] work by reviewed vendor selection criteria articles between 1966 and 1990. In contrast with Ref. [30] finding, His findings highlighted that criteria such as quality, net price, geographical location and production facilities and capacity has been considered as essential criteria among company.

The investigation of vendor selection criteria were continued by Ref. [32] and Ref. [33]. These studies have identified there were decreasing and increasing pattern in importance of criteria and the emerging of new criteria in vendor selection. Most of the criteria proposed in the previous were based on different vendor selection condition and different industry [32]. Research has evident some are the basic criteria across different industry, however there are criteria are likely to be unique to construction industry. Literature has also shown the domination of delivery, quality and cost in conventional construction vendor selection criteria [26], [29], [34], [41]. These criteria might be more crucial in IBS project that based on prefabrication construction material that required effective delivery, transportation cost, and quality control. In literature, there is limited study attempt to thoroughly investigate the criteria and decision process of IBS vendor selection. Only Ref. [27] indicates that delivery, cost and quality are among some generic criteria to select IBS vendor. Thus, due to the variety of criteria available in construction industry, there is a need to investigate the criteria in IBS vendor selection.

4. Research Approach and Findings

As a part of on-going study to developed MADM decision model for IBS vendor section, documental analysis has been performed to gather criteria in construction vendor selection. Initially, 11 journals in construction vendor selection were chosen. An

exhaustive list of criteria from those journals is filtering and categorizing into several categories such as cost, quality, service, buyer and vendor relationship, assurance supply, payment term, and past performance as proposed by Ref. [35]. The classifications of criteria are made by experts through interview. These experts consist of academicians and practitioner in the area of construction vendor selection.

Our finding indicates that there are 72 criteria in construction field that might relate to criteria in IBS vendor selection. From 72 related criteria there are redundancies in the data where some criteria are similar or express with the same context. After the filtering process of redundant criteria, result shown 6 cost, 8 quality, 9 service, 4 buyer and supplier relationship, 6 assurance supply, 1 payment term and 4 past performance. Table 1 illustrates the final criteria. The set of criteria is significant to further develop research instrument such as questionnaire to validate by experts.

Table 1. Construction Vendor Selection Criteria

Selection criteria	References
<i>Cost</i>	
• Total cost	[29][34][21] [7] [36] [37] [35] [38]
• Discount percentage	[29][21]
• Transportation cost	[29][21]
• Cost profit ratio	[39]
• Cost reduction assistance	[26]
• Cost stability	[35]
<i>Quality</i>	
• Technical acceptance material	[29]
• Rejection level	[21] [26] [40]
• Quality management system	[21]
• Pass rate	[39]
• Certification	[26]
• Quality tool	[34] [26] [38]
• Quality stability	[36] [40]
• Failure prevention	[35]
<i>Service</i>	
• Guarantee for delivery late	[29]
• Delivery time of additional material	[29]
• Lead time	[21] [26] [7]
• Time flexibility	[21] [35]
• Quantity flexibility	[21] [26] [36]
• Timely delivery rate	[39]
• Service response speed	[39]
• Delivery	[39] [36] [35] [38]
• Technical assistance and support	[35]
<i>Buyer supplier relationship</i>	
• Compatibility	[34]
• Attitude	[39]
• Relationship with supplier	[37] [35]
• Cooperation and communication	[37]

<i>Assurance supply</i>	
• Ability to receive emergency order	[39] [40]
• Productivity advantages	[39]
• Technical capability	[26]
• Reliability	[26] [35]
• Production capacity and capability	[37][38]
• Technical competence	[37]
<i>Payment term</i>	
• Flexibility in payment	[26] [37] [35]
<i>Past performance</i>	
• Vendor reputation	[35]
• Performance	[7]
• Vendor failure	[36]
• Past record	[35]

5. Discussion and Conclusion

This paper has presented a discussion of vendor selection in construction perspective. Research has indicated the high complexities in decision making process of construction vendor selection. In conventional construction approach, the role of vendor has been considered as a key of project successful. Research has also illustrated the need of decision aid in construction vendor selection not only in conventional construction project yet in IBS construction project. The adoption of IBS has proven beneficial towards enhancing project performance and productivity. As a result, numbers of IBS vendor available in market and led to vendor selection problem among the construction company. Thus, given the important of vendor selection in construction industry, this paper discussed the significant of construction vendor criteria and the potential of a Multi Attributes Decision Making as a decision tools in IBS vendor selection.

This paper has highlighted Multi Attribute Decision Making (MADM) and its integration with other approach such as fuzzy set. A set of criteria is significantly influence the effectiveness of MADM method. Thus, as a part of process to develop MADM method, review on construction vendor selection criteria has been performed. Various criteria have been proposed in the past and try to evaluate them to find out the most suitable criteria for construction vendor selection. Till date, only Ref. [27] has indicates that delivery, cost and quality are criteria in IBS vendor selection. However, research indicates the selection criteria in construction have been expanded and some new ones are introduced responding to the growth of new project needs. Therefore, as a part of process to identify the suitable criteria IBS vendor

selection, a documental analysis in construction vendor selection criteria has been present. Our finding indicates the domination of criteria such as cost, quality, service, buyer and vendor relationship, assurance supply, payment term, and past performance in previous studies. The identification of criteria set in construction vendor selection is significant as a foundation to develop research instrument for our next phase of research.

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