

# Supplier Selection Criteria: A Case in Selecting Best Supplier for Industrialised Building System (IBS) Construction Project

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## Abstract

*Supplier selection is the most important activities in construction supply chain, especially in Industrialised Building System (IBS) construction where most of the building component are not manufactured in construction site. There is a need for accurate decision in supplier selection, which is essential nowadays with the increasingly competitive environment. Inaccurate selection could lead to serious construction problems, such as project delay, and cost overrun. Moreover, with the existence high numbers of criteria and suppliers available, the supplier selection process for a specific project needs becoming more difficult. An interview session was conducted among three decision makers (DMs), then selected the relevant and critical criteria and sub-criteria of a IBS supplier that has been identified from various literature. As a result, cost (total cost and term of payment) and capability (design, problem treatment and mobility) are the most influence criteria and sub-criteria that has been highlighted.*

**Keywords:** supplier selection, Industrialized Building System (IBS), criteria, Supply Chain Management (SCM)

## Introduction

The construction industry plays a vital role in the economic growth for both developing and developed countries. As Malaysian progressively marches towards industrialization, the role of the building is greatly enhanced, with the idea of transforming the aspiration and needs of people into reality. It is a crucial engine for the overall economy and demonstrates a substantial effect on economic growth. Many other industries also rely on the construction industry; for instance, construction consumes 15 percent of total manufacturing output [1]. The demand for innovation is increasing as the economy needs to develop globally and nationally. Recognizing innovation as the focal driver for advanced economic growth, Malaysia has been aiming to boost the nation's innovation as part of the nation's transformation strategy [2].

The introduction of IBS in Malaysia started in early 1960's. Since the introduction of IBS, several of projects has been used IBS in several type of construction project. Generally, IBS attempts to expedite the execution of the project by providing the materials for the project to be produced and constructed readily at the optimum time. The role of purchasing in supply management particularly in Malaysian construction industry has received and continues to receive increasing attention as the years go by. Purchasing enhances efficiency and competitiveness among other benefits but to realize these benefits it is imperative to select and maintain competent suppliers. However, many factors affect a firm's ability to choose the right supplier particularly in IBS. Selecting right suppliers significantly reduces the material purchasing cost and improves corporate competitiveness [3]. According to [4] and [5] many experts believe that the supplier selection is the most important activity of a purchasing department.

However, little attentions are given in literature about construction industry including IBS supplier selection criterion. It is worth to mention that there are multiple characteristics and criteria with respect to industrialized building materials supplying by the supplier to be used in the project; such as delivery time, logistic issues, erection process, cost of purchasing etc. Thus, there is a need to recognize the supplier selection criteria and why these criteria important are important in the selection process.

### **Literature Review**

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 21<sup>st</sup> century business environment, an effective purchasing approach has been addressed as strategic approach in supplier management to achieve business objective and also to fulfil the organisation needs in future [6]. Purchasing in supply management involved activities such as supplier identification, supplier selection, buying, negotiation and contracting, supplier market research, supplier measurement and improvement.

[7] added that the evaluation and selection of supplier is the foundation of an effective decision process in purchasing. Thus, numerous of studies in effective purchasing supplier management has been carried out in the past in numerous of field including construction industry [7-9] However, selecting the right supplier is a difficult task that involves an unclear objective, constraints, and a wide range of criteria in the decision-making process has increased the complexity of this issue [10] and [11].

Several of past studies have been investigated the benefits of proper supplier 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 [8]. The study revealed four benefits from effective supplier selection such as increasing profitability, increasing quality, and decreasing cost. In addition, an intensive literature review study has concluded there is positive relationship between purchasing activities such as supplier selection with overall company performance .

Furthermore, purchasing process through an effective supplier selection such as evaluation of supplier performance also has shown positive effect in reducing total cost of material and increasing quality of product. Material cost reduction is significantly importance in business due to most of the company spend half of their total revenues on materials and component cost.

In comparison with other industry such as manufacturer, decision of supplier selection in construction has been found more complex due to its nature [12]. Supply chain in construction industry involved wide range of component part with different requirement based on variety of project [13]. Other authors also have highlighted the involvement of large number of key participant such as client, consultant, contractor and several of supplier in one project has increase the complexities in construction supplier selection [14].

Moreover, an increasing numbers of IBS suppliers were also increased the complexities of IBS supplier selection problem. Report have shown numbers suppliers 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. These numbers were continued increased 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. This situation has contributed to the complexities in selection of the right supplier for IBS project [15].

With high business competitive environment, the traditional single criteria such as lowest cost is no longer relevant in selection of appropriate supplier [16]. 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 [17].

### **Research Methodology**

A qualitative was used to provide the opportunity for the researcher to obtain an accurate explanation of the phenomenon and thus help the researcher answer the question of 'why' and 'how' [18, 19]. A survey can be readily designed to enumerate the 'what' type of exploratory questions and they can be easily applied in social science research. The major limitation of survey strategy is that it's hard to explain an observed pattern and it fails in adequately answering a 'why' type of question [20, 21]. This research requires an in-depth analysis on critical criteria and sub criteria, with the combination of 'what' and 'why' type of questions in addressing selecting IBS supplier challenges. This method can help researchers understand what criteria in selecting supplier why this criterion has been selected for IBS project in construction industry. The research used in this phase is based on in-depth interviews with semi-structured questionnaire as well as direct observation.

A set of criteria supplier selection was gathered and filtered from literature for the development of questionnaire. Based on that, a brief questionnaire was distributed to decision makers (DMs). There are three (3) decision makers namely DM1, DM2, and DM3 who are responsible for IBS supplier selection in this construction project. During the session, DMs were asked to select attributes that are relevant to IBS supplier selection in Malaysia. They were also asked to suggest any additional criteria that relevant to IBS supplier selection in Malaysian construction project.

An IBS construction project in Pulau Pinang was chosen as a case study. The selection of this project was based three criteria: (1) Government project, (2) IBS construction project and (3) current project (2015-2017). This complex is located at Nibong Tebal, Seberang Perai Selatan, Pulau Pinang, Malaysia.

### **Findings and Discussion on Critical criteria for IBS supplier selection**

Based on the findings (Table 1), there are only 16 criteria selected by decision makers from 40 of criteria. These criteria consist of two (2) sub criteria from cost criteria, three (3) sub criteria from quality, three (3) sub criteria from delivery, two (2) sub criteria from financial, three (3) sub criteria from capability, and three (3) sub criteria from organisation background. In addition, there is one (1) criteria suggested by DMs which is mobility of supplier that fall under capability criteria. The decision makers also had pointed the level of important each of criteria that suite to supplier selection of IBS project. Table 2 summarizes the findings for criteria in selecting supplier for IBS project.

Table 1

**Criteria and sub-criteria of supplier selection**

Criteria and Sub criteria/ Authors	[15]	[18]	[19]	[20]	[21]	[22]	[23]	[24]	[25]	[26]	[27]	[28]	[29]	[30]	[31]	TOTAL
<b>Cost</b>																
Product Cost	X	X	X	X	X	X	X	X	X	X	X		X	X	X	14
Discount percentage	X		X												X	3
Term of payment	X	X											X		X	4
Logistic cost	X		X			X				X						4
<b>Quality</b>																
Technically accept material	X			X												2
Secure storage of material	X											X				2
Low Rejection level			X												X	2
Quality assurance ability				X												1
Certification					X											1
Warranty							X									1
Product Quality		X			X	X			X	X	X		X	X		8
Quality certification										X						1
Quality management level										X						1
Product safety	X									X						2
Product applicability					X					X						2
Product reliability										X					X	2

Table 1

Criteria and sub-criteria of supplier selection (con't)

Delivery															
Delivery Rate	X		X	X	X	X			X	X	X	X	X	X	12
Delivery time for additional material	X														1
Lead time			X			X	X	X						X	5
Time flexibility			X						X						2
Probability of rapid delivery											X				1
The level of information sharing										X					1
Modes of Transportation and Facility														X	1
<b>Financial</b>															
Situation of assets and liabilities									X	X					2
Financial				X					X				X		3
Status of capital operation									X						1
<b>Capability</b>															
Service			X												1
Research and development technology									X						1
Design capability									X						1
Capability of technology service									X						1
Problem treatment capability									X						1
Technical capability				X				X					X		3

Managerial and commercial capability				X						X	2
<b>Organisation background</b>											
Supplier reputation	X			X							3
Business reference				X							1
Supplier viability					X						1
Market share				X				X			2
Relationship with the supplier									X		1
Trust				X						X	2

Table 2

**Attributes for IBS Supplier Selection**

Criteria	Sub Criteria	DM		
		1	2	3
Cost	Total Cost	✓	✓	✓
	Term of Payment	✓	✓	✓
Quality	Certification	✓		
	Warranty	✓	✓	✓
	Product quality	✓	✓	✓
Delivery	Delivery rate	✓	✓	✓
	Time flexibility	✓		
	The level of information sharing	✓	✓	✓
Financial	Supplier Financial	✓		✓
	Situation of assets and liabilities	✓	✓	
Capability	Design	✓	✓	✓
	Problem treatment		✓	✓
	Mobility	✓	✓	✓
Organization background	Supplier reputation	✓	✓	✓
	Business references		✓	✓
	Trust		✓	✓

Based on the findings, cost has been highlighted by DMs that influence IBS supplier selection decision making. Total cost and term of payment are important criteria when assessing cost performance of supplier. Total cost may include to the total expenses required for IBS project component proposed by supplier such as logistic cost, product cost and so on. Another significant sub criterion that related with cost which is term of payment. According to DMs, the term of payment has been considered as significant in IBS project due to the requirement of early payment between 10% - 25% of contract value to supplier by contractor. However, the percentage of early payment is depending on agreement with supplier. DMs in this

study believed that an agreement of payment term between contractor and supplier can also significantly impact the progress of the IBS project.

All the DMs also believed that product quality is important as a criterion in selecting supplier of IBS component. The quality of IBS product can directly impact to building quality, building's lifespan, laboring cost and project delivery time. Warranty of IBS's product is also important as criteria in selecting supplier. Since, there is lack of skill and knowledge specific in IBS products, developer and contractor always highly depend on supplier expertise to determine the quality and maintenance of the product. Warranty can serve as protection to developer and contractor from product failure during the assembling process and during the coverage period of completed building that being used. However, only one DM noted that certification as supplier for IBS product is important criteria in selecting supplier. According to DM1, supplier certification can facilitate developer and contractor in verifying supplier status.

The ability in delivering IBS product according to project timetable and sharing of information plays significant point as a selected supplier. Accurately deliver product timely will much impact on overall cost and progress of the construction project. With the help of information that share among members in construction, any adjustment requirement on IBS product can be made without affect the project scheduled. Yet, construction project always confronts with changes in scheduling due to design changes, improper design, poor site supervision and management so on. Therefore, supplier also need additional requirement under delivery performance, which is time flexibility.

From the aspect of financial performance, supplier should also have good financial background in order to ensure continuous supply of IBS product. Most of IBS project involved with payment based on installation progress. Thus, burden the supplier financial in allocating big capital to produce high volume of IBS products. A more details in assessing financial support of supplier can be reviewed on total of asset and liability.

Supplier also should be assessed on its capability in providing range of innovative design of IBS product. This capability could describe the competency of supplier in meeting the early project design and changes. Beside, problem treatment is another crucial criterion of performance capability. The supplier will be assessed on to what extend it quickly response towards solving and dealing project problems. The construction project is unique and always confront with different issues and problems, which requires different approach to resolve. Based on interview, DMs also agree to add mobility as important criteria under capability. For example, supplier is capable to set up a temporary IBS factory closes to project site. This will bring extra advantage to both parties in term of quick response and low in transportation cost.

Last but not least, the reputation of supplier in term of supplier performance particularly in previous project in Malaysia construction industry should be considered selection criterion to ensure the stability of supplier performance in providing IBS product. It is good to has references from previous client of supplier previous project in order to verify and validate to what extend supplier had involved in IBS projects. Client also needs to evaluate supplier in term of trust. Trust and confident towards supplier must be established. This would ensure the relationship among parties that involve in construction project free from conflict. Each of member can freely share important information and provide support especially in resolving issues and problems.

### **Conclusions**

Based on this research, the conclusion was discovered which is to identify the criteria of IBS supplier selection. Literature reviews reveal some deficiencies of decision model for IBS supplier selection. There are a tremendous number of research have highlighted the importance of supplier selection in construction project. As a part of decision process, the identification of selection criteria is significantly important as

strong foundation towards a better decision making of IBS supplier selection that fulfil the contractor and project needs.

This study identified the IBS supplier selection based on case study of a government project in Pulau Pinang. A total of 16 criteria has been addressed as follows; total cost, term of payment, certification, warranty, product quality, delivery rate, time flexibility, the level of information sharing, supplier financial, situation of assets and liabilities, design, problem treatment, supplier reputation, business references, trust, and mobility. One of the criteria which is mobility was suggested by decision maker (DMs). This set of criteria can be used as a foundation guide for IBS supplier selection among contractor and construction companies.

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