

## Preliminary Study to Identify Challenges and Limitation Factors of Supply Chain Flexibility in Industrialised Building System (IBS)

<sup>1</sup>U. Kassim, <sup>2</sup>C.S. Abdullah and <sup>1</sup>Z.M. Udin

<sup>1</sup>College of Business, Universiti Utara Malaysia (UUM) Changlun,  
Sintok, Kedah, 06010 Changlun, Malaysia

<sup>2</sup>School of Environmental Engineering, Universiti Malaysia Perlis (UniMAP),  
Kompleks Pusat Pengajian Jejawi 2, Arau, 02600 Perlis, Malaysia

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**Abstract:** The preliminary study is to identify the challenge factors and the limitations of supply chain practices in the Industrialised Building Systems (IBS). This field study was conducted directly between the researchers with 30 respondents, representing 30 IBS companies in the Peninsular of Malaysia. A preliminary list of IBS companies were obtained from the IBS Centre located in Kuala Lumpur (CIDB). Data obtained from the pilot study were analyzed using SPSS (Statistical Package For Social Science Version 18.0). From the analysis, it was found that the three factors do exist, there are inflexible facilities organizational capability factor and communication capability factor. This has been identified as the main obstacles in IBS acceptance in Malaysia. The IBS company also has yet to make full use of Information Technology (IT) at its maximum level at which the usage is limited only to accommodate design activities. It has been observed that the Information Technology equipment (IT) has not been used either in logistics or supply chain activities. The developers and contractors only chose IBS after obtaining a certain level of understanding and awareness of the advantages and effectiveness of IBS utilization. IBS supply chain problems can be solved by creating a flow of a flexible supply chain that is perfect and effective. It is hoped that this research could become a pioneering study for future research to further improve the performance of Malaysia's IBS industry development to a greater height.

**Key words:** Industrialised Building System (IBS), flexibility, supply chain, construction, engineering

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### INTRODUCTION

IBS is defined as a construction system in which components are manufactured in a factory environment or offsite, positioned and assembled into structure with minimal additional site work (CIDB, 2003). The perfection of the supply chain process for the Industrialised Building Systems (IBS) began from the planning, designing, molding production and the manufacturing stage of IBS components. So far the production of various products of IBS components in the factory sees the use of the computer systems and machines of modern technology before the end products are eventually marketed to customers. Maryam Qays also defined IBS as a construction system in which components are manufactured in a factory environment or offsite, positioned and assembled into structure with minimal additional site work. Whereas, Nawi *et al.* (2007) stated that an Industrialised Building System (IBS) construction system concept as: "is an alternative construction method

towards sustainable and improvement of construction performance and image. Both concepts are related with movement of innovation to enhance the project delivery and performance in term of cost reduction, quality, work environment, relationships and productivity". Nawi *et al.* (2011) stated the benefits of IBS as follows:

- Optimize the use of materials, repeated use of the mold and can reduce waste of construction materials
- The production from the factory is able to produce better quality products, rational and efficient, better skilled workers as well as repeated procedures and quality supervision and manageable
- The duration of the construction work is shorter: be able to halve the time frame of precast construction 'in-situ' method
- Construction operation is not affected during bad weather because a construction component is produce fabricated in the factory and delivered to the construction site

- Manufacturing work is carried out centrally at the plant and can reduce the total number of workers on construction sites compared to many conventional methods that require the involvement of many workers
- Opportunities are wide open for architectural contractors to be more innovative and creative when IBS systems provide various opportunities for designers and builders to explore creative design in adapting the method of fabricated IBS
- IBS method in construction activities uses environmentally friendly building materials to reduce the effects of pollution on the environment as well as minimize waste on construction sites
- IBS system is able to reduce unskilled and less productive workers
- IBS is proven to reduce the total number of foreign workers in the construction sector (in the case of Malaysia) which previously is there is a large increment in social problems and crimes due to the increase of foreign workers in the country which brings to a very serious and worrisome level
- IBS can reduce overall construction costs as well as the material and labor costs more effectively through practical and large-scale production for the production of construction components of IBS
- Supervision and monitoring become better in improving the quality of products fabricated IBS components
- Practical methods of IBS in construction site has resulted in a more organized orderly, safe and clean construction site environment compared to conventional methods
- IBS is able to boost the image, integrity design of the building and construction to greater heights

Development in construction industry is undergoing evolution and care is needed to spur the development and nation's growth. This term is referred to base on the needs of the main industrial construction plan that is IBS 2003-2010 and IBS 2011-2015 main plans with the non-fully achieve achievement. This issue is often being mentioned by many researcher and author, for instance (Nawi *et al.*, 2011) they stated that only 15% construction project in Malaysia that uses the IBS CIDB Survey Method (2003) whereas IBS study for mid-2007 stated that by using IBS only 10% project was completed for year 2006 as compared to a target of 50% IBS usage in 2006 and 70% by 2008 goals (Hamid, 2008). Whilst, it is found that <35% from the entire projects in Malaysia uses at least one IBS product in year 2006. This statement is supported by Mohd (2001). According to Awwad flexibility plays an important role in connecting the operational strategy to

marketing strategy where it gives an organization the ability to promote new products, immediate adjust to capacity and product adjustment. It also enables an organization to act efficiently with changing situation as according to Wanga supply chain "is an integrated process whereby supplier, manufacturer, distributor and retailer cooperates in effort to obtain raw material/component and changing raw material/component into specified final product and submitting the final products to retailers".

Flexibility in IBS supply chain is needed when there is a change, demand and changing environment in accordance with the current situation. Flexibility breaks ability into efficiency as well as the firm's ability to coordinate the supply chain through efficiency, delivery destination and number of requests. In the supply chain, material moves from one trading partner to another firm and although it is adjacent to meeting customer demand, all partners in the chain must be flexible in carrying out changes. This idea is reinforced in terms of supply chain measurement by a scholar who quoted flexibility aims to meet the needs of specific customer's thus it is viewed as an important strategic performance metric (Gunasekaran *et al.*, 2001).

## MATERIALS AND METHODS

A total of 30 respondents were randomly selected in this pilot study. According to Salleh and Zaidatun, the number of respondents needed for a pilot study is between 10-30 persons. The number of respondents is considered sufficient for the analysis of the external validity and reliability index of the questionnaire. According to Sarrela, the number of responders used in the pilot study is usually not <20 people whereas Ayob (2007) stated that 30 respondents are an acceptable number of respondents.

Based on the pilot study conducted, the researchers have performed all the approaches suggested by most scholars including Nachmias and Nachmias (2000) and Babbie (2001). This method is the most important data collection process because a statistical test will be carried out using this data to achieve the objectives of the study.

**Unit of analysis:** The unit of analysis for this study was compiled and data were collected from practitioners as well as the leaders of IBS. They consist of manufacturers, suppliers, developers, contractors and consultants from selected areas in Peninsular Malaysia.

**Research instrument:** The instrument used in this pilot study is in the form of questionnaire. A questionnaire was

designed based on three core flexibility challenge factors namely capabilities organizational capability and capacity of relationship.

A set of question is divided into five parts, namely A-E. Part A covers questions related to demographic and basic information of respondents who chose the IBS industry. Part B contain questions related to knowledge of issues related to IBS. These questions are to test respondent's understanding and knowledge related to IBS problems as well as reasons why they chose IBS. Finally, Parts C-E contain questions related to research variables. The views and perceptions of the respondents were measured using 7-points Likert scale.

After the implementation of the pilot study, the acquired data were processed using SPSS (Statistical Package for the Social Science) version 18.0. The Cronbach alpha values, namely the reliability coefficient or index was obtained for the entire item in the questionnaire in order to determine the reliability of the instruments used. In addition, the Cronbach alpha for each dimension of the questionnaire was also obtained to determine the reliability of each item contained in the questionnaires.

**Three core factors for ibs supply chain flexibility study:**

Based on literature review, this research focuses on three major challenge factors that are crucial and important. These challenge factors are undertaken by IBS leaders to obtain effective implementation of the system. The inflexibility factors are as follows.

**Core capability factor inflexible facilities (facility, capital funds and transportation):**

Conditions in which to obtain Initial Capital Funds for the IBS manufacturer are inflexible contractors are required to fork out initial expenses to manufacturers in order to book IBS components, according to Nawi *et al.* (2007). IBS contractors are required to pay deposit of about 75% of the total production cost of IBS components before it is sent to contractor's site by the manufacturers. The problem is, local sub-contractors do not have sufficient funding in the early stages of the IBS project and manufacturers have to adhere to stringent terms and conditions and which are not flexible in this situation. The only way to enable contractors to overcome this is by applying institutional bonds from financial institutions as collateral deposit with IBS manufacturers. Wilson *et al.* (1998) and stated that the IBS procurement process is a little different from the conventional method in which material purchases were made before the construction takes place on the construction site. In addition, according to Fikri also Nawi strict terms and conditions are imposed in order to acquire bond guarantee from financial institutions, those of which

are usually conditional and inflexible which serve as an example of problems faced by some new contractors to get bond guarantees from financial institutions. This affects the developmental process of IBS projects.

Inflexible locations in obtaining supply of IBS components, Chung, Nawi, IBS producers are usually located only in industrial areas of big cities such as Klang Valley, Kuala Lumpur, Seremban or Butterworth. This increases the cost of procurement of components in terms of logistics and transportation when involving the budgets of rural projects in Northern parts of Peninsular Malaysia such as in Perak, Penang, Kedah and Perlis. Meanwhile, for states in the east coast such as in Kelantan, Terengganu and Pahang, contractors have to bear the costs of logistics and transportation to obtain the delivery of IBS components to project sites. This has been identified as one of the main obstacles in IBS acceptance in Malaysia, particularly in the northern parts of Peninsular Malaysia.

**Organizational capability factor inflexible information, resources and inventory design changes:**

The inflexibility of the Malaysian traditional building system practice, Nawi *et al.* (2011). The conventional method adopted is known as 'beyond the wall syndrome'. This inflexible method permits the involvement of the manufacturers and contractors only after the design stage when in fact, the requirement ordered by the consumers has to be fulfilled.

This process is rigid whereby the architect produces drawing designs and then passes them to structural engineers. After detailed design specifications are ready, they are then handed over to the quantity surveyor for costing and quotation. The document is delivered to the main contractor afterwards. Then the main contractor must perform further discussions with the manufacturer. They are responsible for the building's structure. The lack of involvement by the contractor in the design stage can create many problems in satisfying the demand condition from consumers at the project sites.

Hamid (2008) also supported this and stated that contractors and manufacturers of the IBS components were only involved after the tender evaluation process. This leads to a lack of integration among participants in the design stage which eventually requires them to redesign which involves additional costs that would be incurred if the IBS was to be adopted. The next problem lies in the design of IBS components that do not meet the requirements of end users. The design of IBS components is 'standard' and difficult to change or not flexible to suit the situation and existing designs at the construction site. According to CIDB (2003) building components is repetitive but difficult and too time-consuming as well as labor-intensive.

This weakness in terms of inflexibility of the design has led contractors to favor conventional methods that are capable of producing components and enable flexible production of construction that can be modified according to the site's actual situation.

In addition, according to Hamid (2008) the need for appropriate training programs in the supply chain, particularly the skills to manage the supply chain process is not emphasized in the company. The lack of initiative in promoting the values along the chain has also been recognized as one of the key issues in this matter.

Moreover, according to him the company has yet to make full use of Information Technology (IT) at its maximum level at which the usage is limited only to accommodate design activities. It has been observed that Information Technology equipment (IT) has not been used either in logistics or supply chain activities.

Communication capability factor: inflexible in communication and integration among designer and construction teams, Nawi *et al.* (2011) and Pearson (1999) stated that weak coordination occurs because the project superintendent is not involved from the early stage. Suppliers of IBS components who are knowledgeable about the info of components manufactured should be appointed as a consultant who gives expert advice regarding information related to the design and coordination of procurement in the supply chain. This can solve the inflexibility problem in improving project performances through the reduce scheduled materials waste, cost issues, communication issues and conflicting relationships.

According to Hamid (2008) divisions in the construction supply chain constitute a major cause of low construction performance and limited selection of IBS construction. He further added that IBS supply chain requires strict control of materials and resource management to ensure that the continuity of the project and delivery of components to the construction site are carried out in timely manner. The supply chain is managed in a way that allows the contractor to fully control the process with the intent to improve efficiency and competitiveness. Hong *et al.* (2001) stated that the current supply chain condition is divided into nature and supported by poor communication, bad relationship as well as the lack of trust and commitment. Wood and Ellis (2005) argued that the relationship between those parties has been driven by cost agenda. These issues are caused by industry's involvement with various parties which are interdependent in the entire process.

According to Khalfan and McDermott (2006) suggested that the supply chain of the IBS construction needs to be managed in a way that allows the contractor to have full control of the process with a view to improve efficiency and competitiveness. It involves the planning

and management of all activities, including procurement, conversion, logistics and coordination between contractors, suppliers, intermediaries and third party solution providers in and around the structure of the company.

Bsria, Scri and Sanderson stated that the collaboration between suppliers and manufacturers from the early stages is important to ensure efficient and timely delivery of components to the sites. Kannan and Tan (2005) explained that the efficiency in moving the supply chain enables firms to exploit capabilities, expertise and technology.

Othman and Rahman (2010) stated that coordination has been recognised as an important supply chain concept. This statement is supported by Ballou *et al.* (2000) where coordination is seen to be the heart of the supply chain process.

These three challenge factors have been raised as major factors in the questionnaire. On the other hand, to get information deemed relevant to the research, the factors are categorized into two perspectives or dimensions namely the chain's flexibility (network operation flexibility, supply chain flexibility and logistics network flexibility).

## RESULTS AND DISCUSSION

Below are the results of the analysis carried out on the pilot study conducted. According to Mohd (2001), the maximum value for the Cronbach's alpha value is 1. If the coefficient value is <0.6, it may be assumed that the items in the questionnaire have a low reliability value which then have to be modified accordingly. Further explanation about the Cronbach's alpha and its corresponding reliability is shown in Table 1.

Cronbach's alpha values obtained for each factor is above 0.70 which proves that this instrument is fit to be utilized (Table 2). Cronbach's alpha value is the highest on the dependent variable, namely the effectiveness of IBS practice ( $\alpha = 0.917$ ) while for the independent variables, the highest values are for communication capability ( $\alpha = 0.827$ ) organization capability ( $\alpha = 0.956$ ) and core capability ( $\alpha = 0.750$ ) variables. The importance of the

Table 1: Cronbach alpha range and level of reliability

Level of reliability	Cronbach's alpha value
High	0.8-1.0
Moderate	0.60-0.79
Low	<0.6

Mohd Salleh and Zaidatun in 2001

Table 2: Reliability of research instrument-pilot Study

Measurement	No. of item	Cronbach's alpha
Effectiveness of IBS practice	7	0.917
Core capability	4	0.750
Organization capability	6	0.756
Communication capability	7	0.827

communication and coordination factors have been listed according to the hierarchy of priorities based on the results obtained through the analysis of this study: The supply chain can come together if the communication and relationship between the parties involved are good, trustworthy and have the commitment to complete a perfect cycle of supply chain. It is also proven that the capability of the organization (improvement on information, resources and inventory flexibility) is the most challenging factor and has so far, limited the main leaders in applying the concept of IBS supply chain perfection in Malaysia.

### CONCLUSION

The aim of the research has been achieved through the analysis of all three challenge factors and limitations. Cronbach's Alpha value is the highest on the dependent variable, namely the effectiveness of IBS practice ( $\alpha = 0.917$ ) while for the independent variables, the highest values are for communication capability ( $\alpha = 0.827$ ) organization capability ( $\alpha = 0.956$ ) and core capability ( $\alpha = 0.750$ ) variables. Cronbach's alpha values obtained for each factor is above 0.70 which proves that this instrument is fit to be utilized. This proves that these factors are indeed inherent in the supply chain system among the main leaders to attain a perfect concept of IBS supply chain. However, these factors revolved more on the operational and internal organizational management of the IBS company itself. Awareness, training and education (ie knowledge) became the major obstacles to the perfection of the supply chain system and improvements are indeed needed for the perfection of Industrialised Building Systems (IBS) supply chain. In this pilot survey stage, 30 respondents are an acceptable number of respondents. A total of at least 30 respondents is the standard size prefix validity of any pilot survey. For the actual questionnaire, >20-30% rate of reaction norms questionnaire will be conducted.

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