

## **Advantages and Setbacks of Industrialized Building System (IBS) Implementation: A Case Study in Sarawak**

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### **Abstract**

Industrialized Building System (IBS) is an innovative technique adopted to increase the efficiency, quality and productivity of projects. However, these advantages are proven mainly for projects located in urban areas only. IBS is not a common practice for projects located in rural areas. Although there were studies about IBS in Malaysia about its advantages and setbacks, these studies were focusing on projects located in urban areas located in West Malaysia only. Hence, this paper aims to close the gap via examining advantages and setbacks of implementing IBS in rural areas of Sarawak, East Malaysia which the level of urbanization is low. Qualitative method with case study approach was adopted. This paper reveals that the advantages of IBS are faster project completion, provides cleaner, neater and safer construction sites, and reduces foreign workers. However, some advantages are not applicable, i.e. high quality of work and lower total construction costs. On the other hand, this paper reveals that there is no significant difference between setbacks of IBS in rural areas of Sarawak, East Malaysia and urban areas of West Malaysia. These setbacks are resistance to change, negative perceptions of the stakeholders towards IBS designs, expensive overall construction costs, lack of knowledge and exposure to IBS technology and lack of IBS manufacturers in industry. Among these setbacks, the lack of local IBS manufacturers and expensive overall construction costs are two significant setbacks. This paper manages to provide an insight for construction firms, as well as policy maker, that are going to implement IBS in their projects in rural areas, especially in developing countries.

**Keywords:** *Industrialized Building System (IBS), Advantages, Setbacks, Rural Areas*

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### **1.0 Introduction**

Malaysia government starts to implement Industrialized Building System (IBS) concept due to the increase of its population and the demand of houses in the country. The conventional construction method is no longer able to cope with the huge demand of houses due to the slow speed of construction, low quality and higher cost of construction [1,2]. Therefore, two pilot projects using precast concrete elements, as one of the IBS concept, were launched in 1966 to produce high rise low cost flats in order to cope with the increasing housing demand. However, they created poor image to IBS due to low quality, leakages, unpleasant architectural appearances and other drawbacks [3]. After that, numerous IBS projects such as housing projects, ranging from low cost houses to high cost bungalows, were also built from 1981-1993. During the period of 1995 – 1998, the use of precast, steel and hybrid construction had successfully contributed to the rapid creation of numerous beautiful and quality structures in West Malaysia such as Bukit Jalil Sports Complex and Games Village, the Petronas Twin Towers and the LRT lines and tunnels [4].

According to Malaysia Economic Report 2013/2014, the construction industry contributed RM26.5 billion equivalent to 18.1% of the total Gross Domestic Product (GDP). In order to encourage the use of IBS in the construction industry, Malaysian

Government mandates the adoption of IBS for projects worth RM10 million in public sector since 2000. As a result, IBS has been used in a total of 331 government projects with a value of RM9.6 billion in the 9th Malaysia Plan. Furthermore, Construction Industry Development Board (CIDB) has upgraded and updated IBS Roadmap (2003 - 2010) with IBS Roadmap (2011 - 2015) which emphasizes on commercial issues [5]. In Sarawak of East Malaysia, a few projects which utilized IBS components in the construction were also successfully constructed. Those projects were the Institute Aminuddin Baki Sarawak, the Faculty of Medicine and Health Sciences of University Malaysia Sarawak (UNIMAS) and the Extension of Kuching International Airport [6].

Today, the construction industry in developing countries like Malaysia is still very comfortable with the use of conventional construction method in most of the construction projects especially private projects. IBS is still not rapidly used as the main construction method [7] even though the conventional construction method is always identified as labor intensive, messy, dangerous [8] and require very proper site coordination in order to get the work done [9]. According to Malaysia Statistics Department, the value of construction work done was RM27.1 billion and the private sector continued to dominate the construction activities with a share of 70% in Quarter 4 in the year 2014. Therefore, project owners from the private sector are constantly under pressure to improve their performance and quality by CIDB Malaysia. Malaysian Government has amended the CIDB Act 520 to empower CIDB as a regulatory body involving in the implementation of IBS. Furthermore, the collaboration across government agencies and local authorities is established foster a culture of IBS usage in the country [5].

Although there were studies about IBS in Malaysia about its advantages[2, 6, 8, 10, 11, 12, 13] and setbacks[3, 6, 10, 14, 15, 16, 17], those studies were focusing on projects located in urban areas of West Malaysia only. IBS is not a common practice for projects located in rural areas, especially in Sarawak, East Malaysia. A recent study was conducted by [6] focusing on IBS adoption and implementation in Sarawak, East Malaysia. According to the findings, from contractors' perceptions, there were six main advantages of IBS, such as cleaner and safer construction sites, faster project completion, more organized site management, high quality and aesthetical value of products, government incentives and high good cost implications. In addition, they also highlighted the contractors' perceptions that prevent the implementation of IBS which were lack of volume to economically use, expensive overall construction costs, weakness of existing components, lack of capital investment, poor demand from public/client and availability of cheap labors in local market. However, they only studied on the contractors' perceptions on IBS adoption and implementation. Furthermore, there is a lack of study by other researchers in the past to investigate IBS on the completed projects in Sarawak, East Malaysia which the level urbanization is low. Hence, this paper aims to examine the implementation of IBS in rural areas of Sarawak, East Malaysia.

## **2.0 Literature Review**

Although researchers define and interpret IBS differently, most of them have similarities in their definitions. Definitions given mainly emphasize on the industrialization process with the utilization of mechanization [3, 8, 18, 19, 20, 21], offsite production which requires transport and assembly of the components [3, 8, 18, 21], onsite production that uses innovative and clean mold technologies [8, 21], standardization of the components produced [20], mass production of building components [18, 21] and minimal

additional site work involved since most of the construction activities are transferred to factory whereby only erection and finishing work are done on site [8, 18]. This paper defines IBS as ‘an innovative construction method where the components are produced at the factory within controlled environment and later will be transported and installed onto an onsite structure with minimal additional site work’.

Previous studies showed that IBS can bring numerous advantages as compared to conventional construction method such as faster project completion [13, 22, 23], provides cleaner, neater and safer construction site [6, 10, 12], produces high quality of work [6, 12, 24], reduces foreign workers on site [12, 23, 24] and lower total construction cost [2, 11, 12].

IBS can cut short the duration of each activity involved and therefore securing the date of completion of a project [13] as its components are normally prefabricated in the factory and installed on site [23]. Therefore, IBS involves less wet-trades especially when concreting work is involved on site [8].

According to [10], IBS is able to provide cleaner, neater, and safer construction sites since less formworks are used on sites and therefore less hazardous to the workers. This indirectly leads to better and more organized site management [6] since it has less site materials [11] and less construction activities on site [10]. In addition, IBS leads to less wastage or dumped materials on site if compared to conventional method. This minimizes environmental impacts and pollutions that may cause conflicts with neighbors or authorities [12].

IBS can produce higher quality of work as prefabricated components are produced under controlled and consistent conditions, thus helping to produce higher quality of work [23]. This can assure that high good cost implication is achieved in IBS projects [6] and thus a huge amount of money is saved by not having rectification and maintenance work [25].

Furthermore, IBS is able to reduce foreign workers on site [12, 23, 24] if compared to conventional construction method which is labor oriented [13, 20]. Most of the construction activities on site are transferred to the factories which utilize large scale of machineries [12, 23]. By reducing wet-trades through IBS, the high dependency on foreign workers in the local construction industry is also reduced, thus reduces the outflow of local currency to foreign economies and at the same time reduces inherent social problems involving these foreign workers [8].

Last but not least, IBS can lower total construction cost of a project by the savings in construction time, labor and material cost [2], mass production of the IBS components [11] and incentives given by government to encourage the construction practitioners to utilize IBS in their projects [12].

On the other hand, previous studies also revealed that there were numerous setbacks that prevent the implementation of IBS in construction industry. These setbacks were identified as resistance to change [6, 10, 15], negative perceptions of the stakeholders towards IBS designs [3, 6, 16], expensive overall costs of construction [6, 14, 17], lack of knowledge and exposure to IBS technology [3, 15, 26] and lack of IBS manufacturers in industry [10].

Most of the contractors resist changing from their conventional construction method because this method has been practiced over decades while IBS is totally new to them. Furthermore, their workers are not familiar with IBS [10]. The availability of cheap

workers in the local market, both locals [6, 10] and foreigners [10, 15] also restrains contractors to IBS.

IBS is often misinterpreted with negative perceptions such as low quality buildings, leakages, abandoned projects and unpleasant architectural appearances [3, 6] and rigid to creativity and innovation [16]. Hence, contractors refuse to use IBS due to fear of customer's rejection [15].

Besides, another setback is expensive overall construction costs of IBS projects. This is caused by high capital investment [3, 17], lack of IBS volume [6, 26] and high shipping cost [14]. Contractors have to contribute extra funding for training of human resources for highly skilled jobs in IBS [2], purchasing heavy and specialized equipment [26], importing foreign technology and wages of skilled workers for installation [27]. Another factor that leads to expensive overall construction cost is lack of volume to economically use IBS, which is outlined by [6]. For small and medium projects, it is not economical to use IBS as the philosophy of IBS is based on mass production [26]. Switching from conventional to IBS would not guarantee significant savings in the cost if only small volume of buildings are being constructed [3]. According to [28], the majority of IBS manufacturers are located in industrial zones in urban areas. If a construction site is located too far away from the IBS manufacturers or suppliers, this will indirectly increase the logistics and shipping costs in a construction project budget [14].

Lack of technical knowledge and experience in IBS [15] and in designing prefabricated components [3] among local professionals and contractors which cause the delay of projects as more time is needed to produce drawing details [15] are another setback that discourage the implementation of IBS. IBS requires high construction accuracy and therefore it is important that the contractors have to be technologically equipped with IBS knowledge [26]. All parties involved, from designers to contractors, must have competent knowledge about the prefabricated components based construction to ensure successful the implementation of IBS [3].

Lack of IBS manufacturers in the industry is one of the setbacks of the implementation of IBS. The number of IBS manufacturers in Malaysia are comparatively low, with only 50 companies registered in Malaysia [10]. However, according to [28], the number of IBS manufacturers has increased to 169 manufacturers, where majority of the IBS manufacturers (i.e. 88%) are situated in West Malaysia.

### **3.0 Methodology**

This paper adopted qualitative method as it answers the 'why' and 'how' of key players' opinions and experience on the implementation of IBS in rural areas of Sarawak as suggested by [29]. This paper used the case study approach as it is strong in reality which may not be captured through experimental or survey research as suggested by [30] and offers better insights by giving access and answers to the details on the area of the study as suggested by [31].

A real case based on a completed IBS project was selected due to its utilization of modular system concept which was supplied from West Malaysia. The project's site was located at Tanjung Manis, around 80 km away from Sibu, the third largest town in Sarawak. The selected project involved the upgrading classrooms, toilets and quarters for five schools with a value of RM13 million. The initial project's duration was six months. However, the entire project was completed with two months delay due to the

unavailability of ready mixed concrete and flooding on site. Reasons choosing IBS modular system were due to its lightweight components and no roof truss needed. The lightweight components could be easily handled by manpower for the installation work as the project sites could only be accessed by river where heavy machineries were not able to be transported. Furthermore, no heavy foundation needed to support the whole building. Hence, mangrove piles were used for this project. On the other hand, the buildings would have high ceiling finish as no roof truss was needed under the modular system.



**Figure 1: Classrooms**



**Figure 2: Toilets**



**Figure 3: Quarters**

The selected IBS project was unique because there was no IBS supplier or manufacturer who produces modular components (sandwich panel) in Sarawak during the construction period. Another important criterion was the location of this project. It was situated at the rural area of Sarawak where the road network was not well developed during the construction period. Therefore, the selected IBS project might have different outcomes from the previous studies which focused on urban areas.

The data was collected through desk study and semi-structured interview. The desk study collected all relevant documents concerning the selected IBS project specifically, including contractor's own internal sources such as company profile, construction drawings, project progress reports, photographs and contract document. These documents offered a method to cross-check the interviews and to manage for retrospective bias as suggested by [32]. The data from the desk study was also used to investigate new or additional research questions, as well as to verify the previous research findings as suggested by [33]. The semi-structured interviews were held in December 2013. Two interviewees were the project engineer and the quantity surveyor of the selected IBS project. Interview's questions were developed from variables in previous studies to ensure the relationship and the continuity of this paper with previous studies. All interviews were recorded by making hand written notes as well as audio-recorded as suggested by [30]. The contents were transcribed accurately into word documents as soon as possible after interviews. Then, the word documents were counter-checked by the interviewer to ensure important views were not been overlooked as suggested by [34].

#### **4.0 Results and Discussions**

This paper agrees with previous studies that certain advantages, but not all, are significant advantages of IBS implementation in rural areas of Sarawak, East Malaysia. Faster project completion, provides cleaner, neater and safer construction sites and reduce foreign workers on site are the significant advantages however provide high quality of work and lower total construction costs are not.

This paper supports previous studies [13, 22, 23] that IBS can have faster project completion as it is factory-produced and only require installation on site with less time consuming activities especially the curing and hardening time required for the concrete casted on site [35]. However, this paper challenges the previous study [23] that the installation process of the IBS components on site is not very much affected by the weather. The installation work of certain IBS components can sometimes be influenced by adverse weather if the installation involves the usage of electrically generated power tools. The installation cannot be conducted during rainy days as these tools will damage if exposed to rainwater.

This paper supports previous studies [6, 10, 12] that IBS can provide cleaner, neater and safer construction sites due to less wet-trades works on site. Comparing to IBS, the conventional construction projects with more wet-trades works leads to the higher accident risks such as workers stepping on the nails protruding from the timber formwork or workers falling through scaffolding ladder access gap and injured [36]. In addition, this paper also supports previous study [12] that IBS projects can have less usage of materials and therefore less dumped materials or wastage will be produced on site. A conventional project which involves concreting and bar bending work will incur average wastage level

in 20% and 25 % respectively. If the same project using IBS, the average wastage level for both will decrease to 2%, which means that the wastage reduction up to 90% [37].

This paper does not agree with previous studies [6, 12, 24] that IBS produces high quality of work. Although the IBS components are factory produced with minimum chances of human mistakes, the problems especially connection cracks and leakage problems occurs during connections on site. This is due to lacking in design consideration which subsequently leads to leakage problems lead to low quality finished work [3]. Furthermore, this paper also does not agree with previous study [6] that IBS project can achieve high good cost implication. This is due to many connection cracks and leakage problems in the building that lead to low quality of IBS building produced and subsequently incur extra maintenance costs. This infers that the quality of IBS project is highly depending on the design of the components, manufacturing of the components and onsite connection [38].

This paper agrees with previous studies [12, 23, 24] that IBS can reduce foreign workers as general workers on site. Conventional construction method is always utilizing huge number of workers to carry out wet-trades works on site [39]. Therefore, with the use of IBS, most of the construction activities especially wet-trades works are transferred to the factory and thus the demand for onsite manual workers to carry out manual jobs, particularly in concreting, bar bending, formwork fabrication work, bricklaying and plastering becomes less.

This paper challenges previous studies [2, 11, 12] that IBS can lower total construction cost. This paper reveals that incentives provided by the government for IBS are able to reduce total construction cost [12] is not applicable to the selected IBS project. The main reason is due to high transportation cost. The selected IBS project site was very far away from the manufacturer, this definitely incurred extra transportation cost. The situation became worse when the site was situated in rural area and had a serious logistic problem. The selected IBS project site could only be accessed through river. This infers that the total construction cost of IBS project is greatly influenced by the location and accessibility of the project site [40] and the government should not generalize IBS incentives across locations.

This paper also reveals that there is no significant difference between setbacks of IBS implementation in rural areas of Sarawak, East Malaysia and urban areas of West Malaysia. This paper agrees with previous studies that the IBS implementation in rural areas of Sarawak, East Malaysia are also restrained by setbacks such as resistance to change [6, 10, 15], negative perceptions of the stakeholders towards IBS designs [3, 6, 16], expensive overall construction costs [6, 14, 17], lack of knowledge and exposure to IBS technology [3, 15, 26] and lack of IBS manufacturers in industry [10]. Among these setbacks, this paper shows that lack of local IBS manufacturers and expensive overall construction costs due to the logistics and shipping costs are two significant setbacks of IBS implementation in Sarawak construction industry. This paper finds that lack of IBS manufacturers in Sarawak are mostly due to low demand of IBS in local projects. This paper reveals that with the developed road network in West Malaysia, there is not much logistic problems when supplying IBS components to the sites. However, the case is different in Sarawak, East Malaysia. Components logistics in Sarawak, East Malaysia is a big issue since Sarawak, East Malaysia is lacking of well-developed supply chain. Many places in Sarawak, East Malaysia especially rural areas, are still not having well developed road network. This incurs extra logistics and transportation expenses in getting

the IBS components delivered to such sites and the delivery of the IBS components may take few days or weeks, depending on how far the site is from the IBS manufacturers.

## **5.0 Conclusions**

This paper manages to draw a significant implication for the construction industry in Sarawak, East Malaysia as the advantages of implementing IBS cannot be generalized across locations. The construction practitioners have to look into the site location where IBS is going to be implemented. They should conduct site investigation to identify site condition, services nearby, and accessibility available [41, 42] prior to IBS implementation. This can solve the problems related to the components logistics that may incur high transportation costs to the project.

In order to encourage the establishment of more IBS manufacturers in Sarawak, East Malaysia as well as more demand on IBS products used in the projects, this paper proposes that the government should provide more incentives to IBS manufacturers as well as IBS contractors. Government should not generalize the incentives for all IBS projects but have to consider their locations. Furthermore, the government should always gather timely feedbacks from IBS manufacturers and construction practitioners in order to solve the IBS related problems that they faced, especially in rural areas.

This paper suggests that the government should give focus to the logistics as it has been identified as one of the main setbacks of IBS implementation in Sarawak, East Malaysia. The government should plan better supply chain by upgrading existing wharfs since delivery of IBS components by using river transportation is prevalent as there are many large and long rivers available in Sarawak, East Malaysia. On the other hand, the government should also make sure that the road network in Sarawak region is well developed for the implementation of IBS in the projects especially projects in the rural areas. With all these upgrading works and infrastructure development, efficient and timely delivery of IBS components to the project sites can be ensured.

Although this paper manages to achieve its research objective, it still faces certain limitations. Firstly, it is inevitably facing the problem that different interviewees might have different values when giving their opinions from strongly agree, agree, disagree to strongly disagree. The potential of biasness by interviewees is mitigated via the triangulation of information from secondary sources (i.e. company profile, construction drawings, contract document and project progress reports). Secondly, both interviewees have a tendency to forget some of the project information since the project has already been completed about four years ago. This problem is mitigated by referring to secondary sources.

The findings may lack of generalizability as it is an exploratory case study with one selected project. Therefore, one clear opportunity for future research of advantages and setbacks on IBS implementation in Sarawak is to conduct the study through a longitudinal perspective. Targeted respondents of future research should have at least few IBS projects completed before. The longitudinal study should not only gather information from one project, but should be from a few IBS projects in Sarawak, East Malaysia. Furthermore, this paper also provides opportunity for future research in comparing among various types of IBS systems implemented in the projects in terms of their respective advantages and disadvantages of the implementation. Targeted respondents of future research should be from those involved in the IBS projects in Sarawak, East Malaysia.

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