Cost perspective for sustainability in Industrialised Building System (IBS) projects

M Z Mohammad¹, E F Ahmad¹ and N S Samsudin²

¹ Faculty of Civil Engineering, Universiti Teknologi MARA, Shah Alam 40450 Selangor, Malaysia.
² Faculty of Architecture, Planning and Surveying, Universiti Teknologi MARA Seri Iskandar Campus 32610 Perak, Malaysia.

mazlinazaira@uitm.edu.my

Abstract. Since 1998, the Construction Development Industry Berhad (CIDB) has been long promoting Industrialised Building System (IBS) in Malaysia. However, the use of IBS has not achieved an impressive number which only 10% and 50% have widely used in the past said CIDB in 2006. This research study focused on why IBS practice is still in an unconvincing market state of use and how sustainability in its cost perspective influences the use of IBS in each project. A questionnaire has been developed consists of four sections and has been distributed to 30 respondents in different IBS projects within the Selangor area in Malaysia. The data has been analysed using SPSS 23 software to determine the descriptive statistics and rank regarding the issues of implementing of IBS in the industry based on a cost perspective. The research study determined the level of understanding of IBS acceptance and awareness among the Malaysian construction industry. The findings encountered the main problems by constructions player while implementing IBS. In conclusion, strategies and recommendations are also suggested.

1. Introduction

Industrialised building system (IBS) is a term used by the local sector specifically Malaysia and the government to show ownership of adapting the industrialisation of building and prefabrication of components in building construction. IBS itself defined as one of the construction methods by means the components are assembled in controlled environment transported and structured into minimal site works [1,2]. Most of the manufacturing components are manufactured systematically using machine. While formworks and other forms of mechanical equipment are manufactured off-site and delivered to site for assembly and erection. Minimal additional site work [3]. IBS have situated in Malaysia more than 50 years and many construction industries embrace IBS as their method of construction, realizing there are more of productivity, reducing risks related occupational safety and health, enhance unskilled and skilled worker’s dependency on manual foreign labour. Other, IBS offer low wastage, lesser site materials and a neat and cleaner environment [1]. On top of that, conventional construction has been criticising for not fulfill the requirements as it includes a vast number of workers, human health and safety. Sustainability in construction is generally responsible for an efficient resource for building a healthy environment [4]. Now, Present environmental and social-economic problems revolve around sustainability. According to [5], IBS view as the most advantageous solutions to reduce waste in
construction. On top of that, IBS is viewed as the best alternatives way to maintaining the sustainability in construction. It can supervise the human resources and cost, shorten the length of construction time and improve the quality of buildings. As compared to other first world countries such as Japan, Germany and United Kingdom has shown a great potential to progress for IBS to progress [6]. These are among the successful project IBS related projects Sekisui Home (Japan), Living Solution (United Kingdom), Open House (Sweden) and Wenswonen (Netherland). According to [7] to the unready state of a decision on choosing IBS over the conventional methods could be led to many other problems and the potential of the IBS unable to be optimised. Problems such as changing orders and delays in production, over budget encountered due to defective decisions in implementing IBS.

2. Literature review

2.1. IBS

According to [6], IBS technology is not new technology adopted in Malaysia since the Ministry of Housing and Local Government visited several European countries and assessed their building system. After that, the second IBS project was constructed at Jalan Rifle Range Penang in 1965, which consist of six block of 17-storey flats and three blocks 18-storey flats [8]. CIDB has been operatively promoting the use of IBS in every construction [9]. IBS is not a new technology. IBS can be defined in all of which every structure of the building such as a wall, slab, column, staircase is mass-produced in a factory or at a site factory undergo tight quality control and minimize the in-situ casting. There are several classifications of IBS modular structure. According to [3] IBS is divided into six components based on the structural aspects for example panel and box system, precast concrete framing, steel formwork systems, steel framing systems, framing timber systems, blockwork systems and innovative product system. Normally, it involves mass production of amount, ensures cost, and time reduction other than raising the quality of the work. The precast concrete components are widely used locally and abroad, and the components products are well manufactured and cured under some quality control from the plant. In addition, at some point the whereby the formwork works as a structure itself after concreting. Construction Sustainability means, alternately maintaining the environment while controlling human resources, cost, construction period and increase the quality of the building [7,10].

2.2. Advantages and disadvantages of IBS

IBS brings many benefits to the construction industry. According to [11] conventional on-site construction has long been criticized as it has long construction time, low productivity, high wastage, and low safety records. They are ways to reduce this one of them is implementing the IBS into every project related and start adopting IBS as a construction role in the industry. Despite there are many advantages of IBS implementation, there are also the disadvantages of IBS. [12] said the IBS manufacturing process needs early attention and a good plan from among all of the construction players. Such support is given by the government but still, usage of the IBS is currently much lower. IBS players do not find the right way or the right chemistry finding solution to challenges that indicates to supply chain of IBS [13]. Several Issues relates to IBS is most of the available workers are still lack of required skill and knowledge. Several workers available are hard to train and to attract labors [10]. On top of that, deficiency in skills and knowledge gave a visible impact to improper assembly of the components [8]. Other, IBS needs a large start-up capital cost, IBS needs investment for setting up the plant, machinery supply, and engineering complexity of the new interface and expenditures of transportation [14]. In addition, [15] stated project characteristics and the economic market are the common factors of IBS construction cost influencer. [10], a lack of knowledge is one of the main issues and disadvantages for IBS. Slow in terms of making a decision whether to choose IBS over the conventional methods to occur and the cost of it eventually hike up [1]. Lack of knowledge on IBS contributes to poor structural analysis and the design for prefabricated components [16].

3. Research methods

In this research, the sustainability aspect of IBS in term of cost in Selangor be stress specifically. This research purposely to conducted to gain knowledge of IBS implementations by construction players.

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Data collection in this research is divided into two categories which is primary and secondary data. Data collected by the researcher is considered as primary data while other researcher collects the secondary data. The secondary data was in the form of articles journals or books. Other, the primary data we to collect with the help of construction players ranging from contractor engineers, manufacturers, clients and such. The questionnaire acquires the respondents to fill on the knowledge on the IBS project that are related, based on their experience before and opinion of the construction method implementation for future reference.

3.1. Data sampling and questionnaire formation
This study focuses on IBS projects and relating to the IBS all over around Selangor. The location of the study is chosen because of the amount of construction player Selangor shows the highest number according to CIDB. The case study refers to the implementation of IBS around Selangor and how the implementation of it cut costs and reduce the time of the construction project. This research study utilizes techniques of quantitative by gathering and collecting all information and data to fulfil the intended objectives. The quantitative research is used to give information in a graphical way. The procedures to collect data throughout this method usually by using a set of questionnaires with standardized measuring instruments, rating scales, and observation schedules. Under this method, the researcher uses the questionnaires to get the variables required or known as primary information to be used to perform the analysis of data. The questionnaire is distributed to qualified respondents’ expert to the IBS construction method, sustainability approach, cost and time management skill. A set of questionnaires was formed and subsequently distributed to the respondents intended to solicit reactions and their opinions on the cost sustainability in IBS. The author’s research was conducting a “pilot survey” over the study area to ensure that questionnaires be distributed to achieve the objectives of the research that have been set. The questionnaire is divided into four main sections includes Section A to evaluates the demographic information. Likert scale method be used to perform the analysis for the following sections. Section B is to answer on the benefit of implementations of IBS. The respondents need to choose an answer from strongly agree to strongly disagree for each point related to the project. There are ten questions prepared in this section to evaluate the satisfaction feedback on services in Section C. Lastly is Section D questions related to the challenges occurred in managing an industrialized building construction project. In this research, a questionnaire was made online by using Google Form. In addition, as a precaution, the questionnaire is printed out as a form of hard copy and distributed physically to the respondent to increase a number of respondents.

4. Results and discussion
Majority of the respondents are working with consultant and contractor companies, there are about 40% of the respondent comes from contractors. Thirty-three percent of the respondent is from consultants and only 27% comes from client or developer background. About 37% have worked in the field for about 5-10 years. Ten percent of the respondent 10 -15 years of experience and the rest at 7% have work for more than 15 years. About 73% of the respondent did have experience in the past with IBS project. While, about 20% of the respondent have not involve themselves in any experience before. Only 7% of the respondent is not sure about having relate to any IBS project before.

4.1. Mean and ranking for each section
According to Table 1, the analysis can be concluded on the benefits of implementing IBS in daily construction work. Data shown above depicts the value of standard deviation and mean for each question where most of the result is then analysed with the aid of SPSS 23 software. Table 2 shown the result on ranking the issues related on cost in implementing of IBS in the construction industry. Justification on each result has been discussing in the following subsection.

4.2. Findings discussion
According to the result, the benefits of IBS, many of the respondents agreed on IBS use less material on site. [17] mentioned less material, less wastage, less volume, and speed up construction can be achieved. The result shows the highest mean on the question, this shows that respondents understand the most to
this question as IBS usage may reduce the number of materials on site. Off-site production creates a more sustainable development for the construction industry to maintain the market value. A recommendation to aid future study should be made to increase understanding of IBS can be made. As mentioned in the literature review, off-site production like IBS panel are manufactured off-site, this shows less material transported into the site and ease the site operation. Site operation is lesser, gain the second most response. This is proven by a previous researcher, [6] mentioned operation on site can be lessen as many of the IBS products are manufactured off-site. The statements are also supported by [6], construction on site can only be minimized and effectively handle by IBS implementation.

| Table 1. Descriptive statistics and rank that aims cost perspective beneficial value of IBS |
|-----------------------------------------------|---------|---------|----------|--------|-----------|
| Description | N | Min | Max | Mean | Rank | Standard deviation |
| IBS uses less material as it is manufacture in factory | 30 | 2 | 5 | 4.1668 | 1 | .79145 |
| IBS site operation is lesser | 30 | 2 | 5 | 4.1333 | 2 | .73030 |
| IBS produced less wastage | 30 | 3 | 5 | 4.1000 | 3 | .60743 |
| IBS keeps the site neat and tidy | 30 | 3 | 5 | 4.1000 | 4 | .60743 |
| IBS promotes productivity(safe) and lessen the hazard | 30 | 2 | 5 | 4.0667 | 5 | .69149 |
| IBS construction reduce number of workers on site | 30 | 2 | 5 | 4.0333 | 6 | .80872 |
| IBS is a quick construction method | 30 | 1 | 5 | 4.0000 | 7 | .98261 |
| IBS utilized minimal skill worker and machinery | 30 | 1 | 5 | 3.6333 | 8 | 1.18855 |
| Transportation cost and time is saved | 30 | 1 | 5 | 3.6333 | 9 | 1.12903 |
| IBS improve human daily skill and increase advancement capacity | 30 | 1 | 5 | 3.6000 | 10 | .96847 |

| Table 2. Descriptive statistics and rank regarding cost perspective issues of implementation of IBS in the industry |
|-----------------------------------------------|---------|---------|----------|--------|-----------|
| Description | N | Min | Max | Mean | Rank | Standard deviation |
| Large scale productivity needs huge amount investment | 30 | 3.00 | 5.00 | 4.3000 | 1 | .59596 |
| Start-up Capital cost is higher to work on | 30 | 3.00 | 5.00 | 4.1667 | 2 | .53067 |
| Issues on training the labor | 30 | 3.00 | 5.00 | 4.1667 | 3 | .79148 |
| Every parties sets different objectives | 30 | 3.00 | 5.00 | 4.1000 | 4 | .71197 |
| Lacks of experience professional | 30 | 1.00 | 5.00 | 3.9667 | 5 | .80872 |
| IBS is avoided due to lack of knowledge | 30 | 2.00 | 5.00 | 3.7667 | 6 | .81720 |
| Unaware of the benefits of implementing IBS | 30 | 1.00 | 5.00 | 3.7000 | 7 | .98786 |
| Lacks of guidance and different approach IBS are hard to be implemented | 30 | 1.00 | 5.00 | 3.6333 | 8 | .80872 |

As suggest by CIDB to increase the number of IBS implementation on site. IBS can be cost-efficient by only adapting the locking brick method. The respondents correspond the most to this as most of them are from the construction player themselves. However, shows the awareness of adapting IBS into the current construction method. To meet expectations project delivery without delay is achievable. [11] mentioned wastage produced between conventional and IBS method has been long criticized. The respondent is well agreed on IBS produce less waste and made the site cleaner. Waste on-site relates to the cost by transporting out the accumulating construction waste on-site. Waste such as resource and material waste on conventional methods is inevitable, but not on IBS adoption as supported by [18], IBS offers the most advantageous solution when it comes to waste. Less percentage of waste shows a cleaner and a tidy site. On top of that, recommendations on future studies can be made on IBS can improve human skills. Based on previous research, [5] suggest that IBS improves capacity and enhancement and quality of human life.

Referring to Table 2 result, the results shows with a highest mean value of them to IBS needs a huge start-up capital. As mentioned by [19], Cost starting up for IBS project is undoubtedly high and become the most concerns for every construction-related party. Normally IBS involves with mass production, mass production means a bigger company to start-up with higher cost of money. IBS needs a bigger investment unlike small start-up company cannot contest and participate in any IBS related projects.
Although, the response from the questionnaire shows the higher mean value on the complication of training the labor. As many of the labor are well conversed in the conventional method of construction. [20] said challenges were encountered during the project phase whereas the labor was stuck with conventional minded method instead of the new IBS method. Management issues will then follow up as supported by [19], the manager has to ensure the workers well understand the method of the construction to accomplish the project and ensure its success. A small portion as only 30 respondents were actively participating in to answer the questionnaire Selangor. In addition, this shows a glimpse of the current construction player perception on the benefits and issues of IBS implementation, however, reflects the cost reliant on IBS implementation as many of the construction player’s contradictory with each other.

5. Conclusion
This research has recognised the sustainability of IBS on its cost perspective. It can be concluded that the benefits of the IBS can be obtained with the study helps the construction industry to bloom in the future. However, not all parties could accept IBS implementation especially the company and individual with less experience in managing the IBS. The study has shown there was not a satisfied level of understanding for Malaysian industry members. On top of that, the awareness and acceptance of IBS should be strengthened and enforce in order for the IBS to use wide in Malaysia. The study has shown there was not a satisfied level of understanding for Malaysian industry stakeholders.

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