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The Study of Industrialized Building System (IBS) Implementation in Terrace Housing Project

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Abstract: In the era of globalization, Malaysia has adopted a construction technology in the construction sector under the term "Industrialized Building System" or "IBS". The application of IBS is to address the problem of high demand of housing in Malaysia. The housing project in Malaysia has play a significant role in contribute the construction industry and growing the economics of Malaysia. IBS were facing some issue when implemented it such as lack of financial project, lack of knowledge, equipment, and machinery. The purpose of this study is to identify the types of IBS, the challenges of IBS implementation and the strategies of IBS implementation in terrace house project. 5 construction company experience in IBS was the target respondent in this research. Qualitative research conducted in this research. Semi-structured interview used to collect data. Content analysis was using in this research to analysis data has been collected. Through the data research, its show that the steel formwork system is the most applied among the respondent. Besides, high capital investment was one of the biggest challenges faced by the contractor and provide training and development program can be the strategies to make sure the employees are qualified to manage the construction project by using the IBS application. In conclusion, the research help and encourage more construction players and beneficial to the contractor in better understanding about IBS.

Keywords: Housing Project, Industrialized Building System (IBS), Terrace House

1. Introduction

In this research have discuss about the benefit, challenges, and strategies of IBS in terrace house project. This research also focuses on the types IBS, the advantage and disadvantage of IBS implementation on construction industry. In 1966, the IBS has been established in Malaysia. Hence, this technology is not a new concept in current Malaysia construction industry (Essays, 2018). The visit to European was successful and they learn a lot of technique and knowledge through their

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housing development programs. IBS is classification into five types of system. These are pre-cast concrete framing, block work system, steel formwork system, steel framing system and timber framing system. According to (Md Azree *et al*., 2014).

IBS bring a significant amount of benefit and profitable rewards compared with conventional construction method. The IBS can enhance construction industry with measured by productivity, construction time, decreasing on dependency on foreign labour, reduction on cost of construction and minimize construction wastages. Although the Malaysia government has promoted the IBS to the construction sector to achieve the advancement in construction technology but the implementation in Malaysia construction sector is still very low if compared with the conventional methods (Thanoon & Kadir, *et al*., 2003).

1.1 Research Background

Industrialized Building System, known as IBS, indicate the application of prefabricated of components in building construction and project. It also defined as the technique of construction which producing the IBS construction components in indoor which environment are able to control, on or off-site and then supplied, located and assembled to form a structure with minimal extra site work (CIDB, 2019). This is because there are few elements need to control to prevent structural cracking like temperature, humidity and weather (Lim, 2006). The IBS consist of five types of construction components which are fabricated steel structures, precast component systems, innovative mould systems, prefabricated timber structures and modular block systems. According to Lim (2006), industrialized building system can be defined as mass production in a factory or at the site factory depend on standardize shapes and dimensions. Thus, to be ready for application of such requirements to construct a building, the commodity will be transported to the construction site.

1.2 Problem Statements

Financial of the project is the main challenges when adoption IBS technology into the terrace house project. According to Thanoon *et al* (2003), the cost of IBS is higher compared with conventional building system due to intense competition. So, the economic advantages of IBS are not well known in Malaysia.

In addition, most of the terrace house developers and building companies are lacking IBS knowledge and professional skilled worker (Zainul, 2010). Besides that, production, molding and fabrication are unable to proceed due to lack of guideline panel organization such as design engineer and land surveyor to implementation of IBS (Md Azree & Abd Rahim, 2016).

The equipment and machinery need for IBS construction requires higher cost to implementation (Nawi et. al., 2005). The higher investment cost on capital cost is needed by IBS because it needs to provide skillful labour, automated machines and mechanized equipment (Lovell & Smith, 2010).

The other issue is conventional construction method still carried out because they not willing to change their mind and prefer using old method. According to the research from Md Azree *et al*. (2014), there were about 90 percent of the respondents admit that they are familiar with the IBS, but this method is rarely used in terrace house project. The other factor is most of them are belief using IBS requires high construction cost than conventional construction method (Goodier & Gibb, 2004). This is obviously the main strategy to increasing the use of IBS.

1.3 Research Questions

Based on the identified issues, the research has raised three questions as below:

(i) What are the types of IBS application in terrace house project?
(ii) What are the challenges of IBS implementation in terrace house project?

(iii) How are the strategies of IBS implemented in terrace house project?

1.4 Research Objectives

This section will be carried out based on three main objectives as below:

(i) To identify types of IBS application in terrace house project.
(ii) To identify the challenges of IBS in terrace house project.
(iii) To study how the strategies of IBS implemented in terrace house project.

1.5 Scope of the Study

The scope of research focused on the implementation of IBS in terrace house project. The area of research is selected in Johor Bahru because Johor Bahru is the second highest construction projects in that state (CIDB, 2019). It achieved RM 30.1 billion which is 18.4% of the overall construction projects in Malaysia. Among these RM 30.1 billion, a total of RM 27.4 billion or 91.1% of these projects were from the private sector (CIDB, 2019). Besides that, type of property that Malaysian most preferred is terraced house which have the percentage of 29% (Viktor, 2020). From the Department of Statistics Malaysia, the population and demography in the Johor is 32.68 million with the area of 19,166 km2 (Department of Statistics Malaysia 2019). Therefore, when there are some increasing in customer demand, there are running short of supply. The statistic from CIDB shows that Johor is the third highest of IBS contractors registered with Construction Industry Development Board (CIDB) which have the total registered project of 813 (CIDB, 2019). Hence, the research carries out the research in this area would be provide a credible research and finding to the research.

1.6 Significance of the Study

The Malaysian construction industry plays an essential role in building country wealth and development of the social and economic infrastructures and buildings in order to achieve the inspiration to be a developed nation in 2020. The IBS was significant because it achieves social benefit and economic benefit. Besides that, it also achieves convenience and efficiency in construction project. This study will be beneficial to the contractor in better understanding about IBS. After carrying out the research, it will know what type of IBS application in terrace houses. Furthermore, it will also find out the barrier that may give impact on the implementation of IBS in terrace houses and in order to determine the strategies of IBS implementation in terrace house project.

2. Literature Review

2.1 Definition of IBS

The definition of IBS is different due to the author's different profession and philosophy. According to Rahman & Omar (2006), they product, create and manufactured in factory using prefabricated materials in construction. Then, the building component are delivered to the location to be set up and assembled. The IBS also defined as a construction process which involved efficient management, preparation and control resources used. The integrated manufacturing is the significant part of the IBS which this process is well planned and produce the large scale of construction component (Lessing *et al*., 2005).

2.2 Types of IBS

Industrialized building system (IBS) is classification into five type of system. These are pre- cast concrete framing, block work system, steel formwork system, steel framing system and timber framing system.

(a) Precast Concrete Framing

This system is widely use because it achieves a lot of benefit such as quality control, speed in construction and appropriate application to regularly modular system (Nurjaman *et al*., 2008).

(b) Blockwork System

This method is avoiding from using mortar and the demand of skilled labour. The construction process will cut the overall time because mortar is not needed to be laid on every single brick (Avila & Jensen, 2015).

(c) Steel Formwork System

Steel formwork system is one of the low-level prefabricated IBS because it consists of site casting and face the problem of structural quality control. The product is usually high quality and achieve the fast construction by decreasing the use of site labour and material requirement (CIDB, 2003).

(d) Steel Framing System

steel framing system is a technique which using steel columns and horizontal beams to form a frame to attach the floors, roof, and walls of a building. This system consists of light steel trusses with benefit of cost-effective and steel portal frame system to replace the heavier traditional hot-rolled sections (Mohamad Kamar *et al*., 2011).

(e) Timber Framing System

It is using prefabricated wood and wooden products in structural and load bearing elements. Although the timber framing system have a lot of benefit, but the cost and availability of the timber product is the barriers in construction (Mohamad Kamar *et al*., 2011).

2.3 Challenges of IBS

2.3.1 Advantages

According to Md Azree *et al*., (2014), IBS bring a significant amount of benefit and profitable rewards compared with conventional construction method.

(a) Faster Completion

The IBS can shorten the duration and faster the completion of a construction project because the component of construction is using prefabricated method which can directly assembled on the site (Yahya & Shafie, 2012).

(b) Reduce Dependency of Foreign Labour

The use of IBS will bring the benefit on relief the pressures of labour requirements in order to increase quality and productivity (Bari *et al*., 2012).

(c) Reduce wastage

According to Kermanshahi *et al*., (2015), the research shows that the IBS has produce less wastage during construction activities compare with conventional construction method.

(d) Not Affected by Poor Weather

Climate conditions do not impact the manufacturing process because prefabricated parts are designed and manufactured in a managed environment. (Mohd Nawi & Lee, 2011).

(e) Environmentally Friendly

The advantages of IBS are the construction project is built in environmentally friendly way with using the available building materials (Mohd Nawi & Lee, 2011).

(f) Reduce Cost

According to the research on Badir *et al*. (2002), there are 86% of respondent admit that the IBS method can efficiency reducing the overall construction cost.

2.3.2 Disadvantages

Although the Malaysia government has promoted the IBS to the construction sector to achieve the advancement in construction technology but the adoption in the Malaysia construction sector is still very poor if compared with the conventional methods (Thanoon, Abdul Kadir, *et al*., 2003). This may be due to:

(a) Higher Capital Investment

Suppliers need higher cost to manufacturing casting beds, supplying machineries and hire skillful labour (Wong *et al*., 2018).

(b) Insufficient Skilled Worker

The quality of prefabricated components and building which produce by the worker with lack of experience and poor knowledge cannot be guaranteed (Luo *et al*., 2015).

(c) Difficult to Modify after Installation

According to Md. Ali *et al*., (2018), the respondents mention that once the factory had started to produce the prefabricated component, it is a minimal chance to changes the decision.

(d) Transportation Limitation

The IBS require sufficient channels to transport all the components to the construction site for assembly work (Md Azree & Abd Rahim, 2014).

(e) Lack of IBS Manufactures

Malaysia has around 274 manufacturers of IBS components are registered with CIDB and component produced only can built 25,000 housing units every year (Pavither, 2019).

(f) Large Construction Site

the crowded cities cannot provide the require area for the plants, heavy construction equipment, tower cranes and storage for IBS components (Md Azree & Abd Rahim, 2014).

2.4 Strategies of IBS in Terrace House

In order to increase the application of IBS, different strategies can be applied and implement. This is because the use of IBS in Malaysia is still poor.

(a) Produce Better Quality

The better quality of IBS component can be manufactured by establishing a research and development center to ensure the prefabricated concrete components are in good quality (Lim, 2016).

(b) Managing Supply Chain

The supply chain needs to be managed in full control of the process to increase efficiencies. The supply chain comprising of procurement, conversion, logistics and coordination by planning and management (Kamar & Hamid, 2011).

(c) Training and Development Programme

According to the Lim, (2016), the workers should be given training and development programme. This strategy is important to make sure the employees are qualified to manage the construction project by using the IBS application.

(d) Increase Research and Development Centers

According to the Lim (2016), The number of research and development centers for IBS should be increase so that the IBS components can produced in high quantity and quality to supply housing project.

(e) Proper Planning

Before the completion of the project, it should identify competent suppliers or manufacturers to supply the products (Mohd Nawi *et al*., 2007).

(f) Developing Specific Rules and Regulation

The government should take some action to ensure that the implementation of IBS policies is implemented, thus initiate motivations (Azman *et al*., 2010).

3. Research Methodology

3.1 Research Design

In this study, the interview was the resources of the information collection and result which obtained from the interviewee. The literature review analysed and studied to achieve the objective of this study. The result will be gathered to understand the study of the implementation of IBS in terrace house project.

3.2 Data Collection

The first step for the data collection was formed the literature review. Second, respondent target set as contractor in the Johor Bahru which had the experience and knowledge on IBS. During the third interview questions were formed based on the objectives of the study. In the last data were collected in the written form by transcript the verbal information from the respondent.

3.3 Data Instrument

This research used qualitative method to collect data. The findings of the research can be analysed analytically or descriptively based on data and the approach implemented in the research. According to Naoum (2012), qualitative research is 'subjective' in essence. It underlines the definition, experiences, and description.

So, to achieve objectives 1, 2 and 3, five selected construction company that have experience and technology in IBS at Johor Bahru has been interview. The interview question divided into five section. Section A was about demographic information about respondents. Section B was related with objective 1, to identify types of IBS application in terrace house project. Section C was related with objective 2, to identify the challenges of IBS implementation in terrace house project and section D was related with objective 3, to study how the strategies of IBS implemented in terrace house project. The interview was easily obtaining the detailed data and information by respondents which provide clear answer. The interview questions are prepared for the interview section with specific respondents. Furthermore, pilot test was conducted to ensure the questions was understanding by the specific respondents.

3.4 Population

The concept of target population can be defined as the population about which information is desired and wants to make inference by the researcher. However, it is often not proper to recruit the entire target population (Majid, 2018). According to CIDB (2019), there have 813 IBS projects registered with CIDB in Johor State so that the size population is 813. The sample of researcher is from the IBS contractor regarding to implements IBS project in Johor Bahru.

3.4.1 Interview Sampling

The researcher was applied the purposive sampling technique to collect the data. The purposive sampling was selected in this research because it recruits the participants depending on their required status or experience and known the specific knowledge which researcher needed (Gentles *et al*., 2015). According to Cresswell (2007), the minimum sample size for qualitative method is between 5 to 25. Hence, the sample size with 5 interviews was suitable for the research and was easier to analyse the content based on the different source.

3.5 Data analysis

The data analysis method in this research used the content analysis. Content analysis was focusing on the communicative nature of language while paying attention to the content or contextual meaning of the text (Hsieh & Shannon, 2005). This research method can help to reveal trends and themes (Wilson, 2011).

4. Results and Discussion

4.1 Interview Respondent's Demographic Information

A total of 5 Johor Bahru respondents engaged in this research after a variety of selections in order to achieve the objective 1, objective 2 and objective 3 in this research. The selection is based on the experience of the respondents had been exposed to the construction industry and their career position as shows in Table 1. From the table, the higher year of experience is 32 year which is Respondent 1 while the lowest year of experience is 6 which is Respondent 3.

Table 1: Respondent's Demographic Information

Respondents	Career Position	Year of Experience
Respondent 1	Contractor	32
Respondent 2	Contractor	30
Respondent 3	Contractor	6
Respondent 4	Contractor	15
Respondent 5	Contractor	10

4.2 Objective 1: To Identify Types of IBS Application in Terrace House Project

This section is to analyse the findings from the respondents on what types of Industrialized Building System (IBS) that construction company application in terrace house project through semi-structured based interview.

4.2.1 Type of IBS Application to Respondent's Construction Company

Table 2 indicate the type of IBS that had been used in respondent's construction company. From the findings, most of the respondent's company are using the steel formwork system instead of other IBS system for application to their construction project because of the benefit on cost-effective, fast construction and high quality.

Table 2: Type of IBS Used

Respondents	Type of IBS Used	Justification
Respondent 1	In situ steel form for wall and floor slab (Steel form work system)	This system in line with our company multiple development across the country
Respondent 2	Prefab roof truss system (Timber Framing System)	Most of the construction company adoption
Respondent 3	Precast method and cast-in situ method (Precast concrete framing)	Fast and reliable depend on the working area
Respondent 4	Steel formwork system	More strong and durable
Respondent 5	Steel formwork system	

4.2.2 Type of IBS that never Application to Respondents' Construction Company

From the findings, it can be concluded that most of the company avoid using the IBS system is precast concrete framing system. This type of IBS system is the least application on industry company because require high construction cost as mentioned by Respondent 1 and Respondent 2. However, the Respondent 3 and Respondent 4 do not have any comment given on this interview question. The reason provided is that the company support all of the IBS construction method.

Table 3: Type of IBS that never Used

Respondents	Type of IBS that never Used	Justification
Respondent 1	Precast column, beam, and slab (precast concrete framing)	High set up and logistic cost
Respondent 2	Drywall (Precast concrete framing)	High cost
Respondent 3	-	-
Respondent 4	-	-
Respondent 5	Precast concrete framing	High cost

4.3 Objective 2: To Identify the Challenges of Industrialized Building System (IBS) Implementation in Terrace House Project

4.3.1 Advantages

Table 4 indicates the respond from the respondent's point of view and the advantages of implementation IBS. Most of the respondents agree the statements that mentioned in the interview

Table 4: The advantages of IBS

Respondents	Advantages					
	Faster completion	Reduce dependency of foreign labor	Minimize wastage	Not affected by weather	Environmentally friendly	Cost reduction

Respondent 1	Yes	Yes	Yes	Yes	Yes	No
Respondent 2	Yes	Yes	Yes	Yes	Yes	Yes
Respondent 3	Yes	Yes	Yes	Yes	Yes	Yes
Respondent 4	Yes	Yes	Yes	Yes	Yes	Yes
Respondent 5	Yes	Yes	Yes	Yes	Yes	Yes

4.3.2 Disadvantages

Since there are some disadvantage in implementation of IBS system in construction industry, hence they must be faced some barrier when application the IBS system. The barrier can be classified into six types which are large capital investment, insufficient skilled workers, difficult to modify, transportation problem, lack of IBS manufacturers and large construction site required.

Table 5: The disadvantages of IBS

Respondents	Disadvantages					
	Large capital investment	Insufficient skilled workers	Difficult to modify	Transportation problem	Lack of IBS manufacturers	Large construction site
Respondent 1	Yes	Yes	No	Yes	Yes	No
Respondent 2	Yes	No	Yes	No	No	Yes
Respondent 3	Yes	Yes	Yes	Yes	Yes	No
Respondent 4	Yes	Yes	Yes	Yes	Yes	Yes
Respondent 5	Yes	Yes	Yes	Yes	Yes	Yes

4.4 Objective 3: To Study how the Strategies of IBS Implemented in Terrace House Project

Since the system of IBS still inadequate in all aspects, hence strategies is required so that to improve and increase the used of IBS in Malaysia. The strategies mentioned at the table 6 which are provide training, increase Research & Development Centers, develop rules and regulation, managing supply chain and produce better quality.

Table 6: Strategies of IBS

Respondents	Strategies				
	Provide training	Increase R&D	Rules and regulation	Managing supply chain	Produce better quality
Respondent 1	Yes	Yes	Yes	Yes	Yes
Respondent 2	Yes	Yes	Yes	Yes	Yes
Respondent 3	Yes	Yes	Yes	Yes	Yes
Respondent 4	Yes	Yes	Yes	Yes	Yes
Respondent 5	Yes	Yes	Yes	Yes	Yes

4.5 Discussions

(a) The Type of IBS Application in Terrace House Project.

The objective has been determined through the literature review and the point of views from the respondents. A conclusion on this objective can be made through the findings showed that, nearly all of the respondent's construction company using the steel formwork system as their IBS construction method. The steel formwork system is stronger and more durable in construction project. This finding can be proved by the Das *et al*. (2016) study which stated the steel formwork system required high operation cost, but it has long lifetime and able to reuse in many construction projects. However, the least application of the IBS system is precast concrete framing system. This system has limited the building design flexibility and hard to modified. This finding seen to be true with Md. Ali *et al*. (2018) study which state that once the prefabricated component assembly, it is a minimal chance to modify the structure. If a concrete wall is to be removed for adjustment, the overall stability of the structure may be compromised.

Through the result from the studies, the construction company most application is steel formwork system as their IBS construction method. However, the least application IBS system is precast concrete framing system. Although this system is widely used in construction industry as mentioned at Jalil *et al*. (2017) study, but it subject to individual developer and product combination. Objective 1 has been achieved.

(b) *The Challenges of IBS Implementation in Terrace House Project.*

The cons and pros of application IBS had been determined. Through the finding it shows the variety advantages of the IBS implemented in the construction project. According to the respondents' point of view, the IBS give the benefit in reducing. The IBS will shorten the time and speed up the execution of the building process, since the construction part uses a prefabricated system that can be immediately constructed on site. Second, IBS can also lead to reduce dependency of foreign labour on the construction site. The contractors prefer to hire local skilled labour rather than foreign skilled labour (Wong & Lau, 2015).

Minimize the wastage of the materials used and ensure the construction site maintain cleanliness is one of the advantages of IBS. The main wastage of the IBS method is metal-type component, and these wastages will be reuse and recycled in another construction project (Majid *et al*., 2011). Besides, IBS construction process is not impacted by climate condition. The prefabricated part is produced and constructed in a managed environment since weather interruptions are an uncontrolled and unpredictable factor which can cause the delay of the construction project (Rippon, 2011).

The application of IBS is different with conventional method because the conventional method will produce a significant of pollution. However, the application of IBS is environmentally friendly by using the available building materials. This advantage has changed the social perception on construction industry. Last, the application of IBS gives significant cost decrease for the overall project cost. The less employees are required at the site lead to the cost can be minimized in terms of wages (Badir *et al*., 2002).

In the other hand, the disadvantages of the IBS had been determined. Through the finding it shows high capital investment cost is the major challenge that commonly faced by the contractor. The higher cost is required to manufacture and produce IBS component and hire skilled labour to maintain the progress of construction project (Wong, Lin, & Chong, 2018). Second, insufficient skilled worker is one of the issues. the quality of prefabricated component and building will be poor due to lack of experience and poor knowledge of IBS. However, this reason can be explained by because certain type of IBS construction is not popular in Malaysia and the workers are still not familiar with the new system (Luo *et al*., 2015).

For IBS construction method, the prefabricated component is difficult to modify the structure after the installation because the reason of its size and irregular structure. Prefabricated component commonly perceived to be large and may reach oversized dimensions in fully prefabricated

components or items with irregular shapes. Besides, the large component of the size has faced the obstacle when transportation. Hence, The IBS needs adequate channels to deliver all materials to the construction site to conduct assembly work.

The lack of IBS manufactures in construction industry indeed will influence the application of IBS because involves very intensive capital investment. The lack of manufacturers in producing IBS components and materials will lead to decrement housing unit built every year (Wong & Lau, 2015). Last, IBS require large construction site for the plants, heavy construction equipment, tower cranes and storage for IBS components. Hence, is can clearly be seen that some construction site the logistic have constraint space.

Through the result from the studies, the IBS can benefit in term of time, cost and labour. On the other hand, the major challenges can be concluded as the large capital investment that commonly faced by the contractor.

(c) The Strategies of IBS Implemented in Terrace House Project.

The strategies of IBS implemented in terrace house project had been determined through the discussion in this objective. According to the respondents' point of view, workers should be given proper training and development program to increase the reliable to manage the construction project using the IBS application (Lim, 2016). Second, increase the research and development centers for IBS. The research and development centers can give guidance to construction player using IBS. Hence, the dependency on foreign technology and expertise can be reduced.

Government should responsibility on developing specific rules and regulation. This approach will enable skilled parties in the construction industry and have a stronger knowledge base to enhance decision-making and ensure the effectiveness of the application of IBS construction projects. Besides, managing supply chain is the part of the strategy. This finding seen to be true with Shukor *et al*. (2011) study which stated that the supply chain needs to be managed in full control of the process to increase efficiencies. For instance, managing the supply chain to deliver IBS to construction clients. This is because in order to eliminate the challenges and difficulties that occur during the timely arrival of building products on site, the IBS supply chain requires tight management.

Last, IBS component should be produced and manufactured in high quality to increase more construction industry involve in IBS. Hence, the government play an important role in provide more benefits to IBS suppliers and IBS contractors. Government does not generalize benefits for all IBS projects, but should consider their sites. In addition, the government should always collect feedback from IBS manufacturers and construction player to resolve the IBS-related issues they have faced, especially in rural areas.

5. Conclusion

IBS play an important role in developing and boosting construction industry in Malaysia. The application of IBS is to address the problem of high demand of housing in Malaysia. The housing project in Malaysia has play a significant role in contribute the construction industry and growing the economics of Malaysia. From the finding, we can know that the steel formwork system is the most favorite IBS system among the construction company because benefit in term of cost, time, and quality. Besides that, the findings show that the precast concrete framing system is the least application among these respondents' construction company because of high set up and logistic cost. Other than that, most of the respondents agree the statement that IBS can benefits in term of time, cost, and labour as well as the benefit of not affected by weather and environmentally friendly. Through the interview, all of the respondents mentioned that the biggest obstacle is financial problem.

Thus, the strategies mentioned in the research such as provide training, increase Research & Development Centers, develop rules and regulation, managing supply chain and produce better quality is required to enhance the IBS in all aspect.

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