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Industrialized Building System in Malaysia: Challenges and the Way Forward

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ABSTRACT

The industrialized building system (IBS) has been proposed in several studies as the solution to meet the intensive demands for houses. The advantages of this system can not be neglected. Reducing *construction time*, *reducing* the dependency on foreign workers*, enhancing the quality of buildings and providing safer, cleaner and neater working environment are significant benefits that using industrialized building system can add to the construction industry. Nevertheless, this system has also its limitation. The developers in construction sector prefer using conventional method. Therefore, there is a need to determine these constraints and propose suggestions to solve them. Thus, a questionnaire survey study was carried out to determine the main constraints that encounter the application of industrialized building system in Malaysia and propose suggestions to improve them. The results illustrated that*

Keywords: *Iindustrialized building system, Limitations of IBS, Constraints of IBS, Suggestions to improve IBS.*

INTRODUCTION

After the Second World War, the industrialized building system has been proposed in several European countries as the solution to provide the intensive demands on houses which occurred due to severe devastation in construction sector. The alternative choice to use conventional method which is time consuming and labor intensive was the prefabricated construction system [1]. European countries have achieved great implementations in this field since starting. In Malaysia, the prosperity and high economic growth have created high demands in construction sector [1]. Minister of Housing and Local Government of Malaysia visited several European countries in early sixties and evaluated their housing development program [2]. After that visit, the government adopted two pilot projects, the first project in Jalan Pekeliling in Kuala Lumpur consisted of 3000 units of low cost flats and 40 shop lots (7 blocks of 17 story flats and 4 blocks of 4 story flats) using the large panel Danish System. [3].

After that, in 1965, the second project was implemented in Penang in Jalan Rifle Range, consisted of 3,699 units and 66 shop lots (6 blocks of 17 storey flats and 3 blocks of 18 storey flats), using French Estiot System [4]. Because of using European systems, the design was inefficient to meet the need of Malaysian life such as wet toilets and bathrooms. Therefore, the problems of leakage and sealant have become the common issue and contributed to bring bad reputation to industrialized building system [5]. Shoddy installations due to shortage in experience had also contributed to bring bad reputation to this system. Now these problems have become a part of early attempt for the previous decades, and precast technology has since improved. [1].

CONSTRAINTS OF IBS

The main constraints of industrialized building system which have been collected from several studies can be mentioned as follows:

1- The fluctuation in construction markets and demands for large housing projects make the using of prefabricated building system perilous. Therefore, many developers alienate to conventional system [6].

2- Academic curricula in universities and institutes provide inadequate educational courses about IBS and MC (modular coordination) principles. Thus, the players who are involved in this field have more tendencies to use the familiar conventional method. The shortage of adequate awareness with industrialization among building professionals is the greatest hindrance to its successful application in practice [6].

3- Bad reputation of prefabricated building system due to the unsuccessful initial stage which occurred due to poor quality control and lack of technical experience and caused several defects such as blemishes, cracks, moisture percolation, and poor thermal insulation in completed buildings [6].

3- The inability of prefabricated components to change which might be required in buildings over its economic life especially in small span room size [6].

4- The weakness of connection and jointing systems in IBS. These systems are very critical and sensitive to the error and sloppy work [6].

5- Shortage in raw materials, supply delay, and bad weather which affect on transportation are the main reasons for delay in IBS projects completion [7].

6- Enormous capital cost which include set up the plant, supplying machinery and moulds, and the expenditures of transportation process (amounts to 3%-5% of their total cost for distances not exceeding 50km-100km [6]. The cost can be reduced only in large projects when using repetitiveness in design [8].

7- Cheapness of unskilled workers make the contractors prefer conventional method against prefabricated system [2].

8- The fragmentation and diversity in construction industry sector make it is difficult to organize IBS planning stage which need consensus among parties [2].

9- Shortage in experience among workers. Many foreign skilled workers had left the country after the widespread crackdown on illegal foreign workers in 2002. The new batches of foreign workers do not possess the required skill and have to be retrained [2].

10- Shortage in IBS information and researches. The practitioners could not accept this system unless the benefits of IBS are well documented [9].

11- Transportation process also has its limitation like difficulties to access to site and difficulties to transport big components from factory to construction site [8].

12- Storage process needs large area in a factory to store IBS components and area for trailers and cranes movement [8]. This will add more cost to establish factories.

PROBLEM STATEMENT

In these few years, the enormous increasing of population has generated intensive demands on houses. According to (Chen, 2000), Malaysia needs a total of 8,850,554 houses between years 1995 to 2020 on average 1,790,820 units to be built for every ten years. This means that the construction sector must adopt fast method and accelerate its implementation to cope with these demands. Therefore, the solution was to adopt the industrialized building systems (IBS) in construction sector and designing plans to improve this system. The emphasizing on IBS from Malaysian government has become quite high in last few years. The first attempt to adopt IBS in construction sector from the government was in early sixties [2]. Although IBS has been introduced for more than 40 years, however the construction industry still applies the conventional method which has been proven dirty, dangerous and wasteful [11]. There are some problems in applying IBS that lead the developers in construction sector to prefer using conventional method. Therefore, there is a need to determine theses constraints and propose suggestions and recommendations to solve them. Thus, a questionnaire survey study was carried out to determine the main constraints that face the application of industrialized building system in Malaysia and to propose suggestions to improve them.

METHODOLOGY

4.1 Collecting Data

The data required for this study was collected by developing questionnaire forms which were designed carefully and accurately to be completed from the respondents in shortest time possible. The questionnaire had been done in two phases. The first phase was pilot survey to pretest and find out if there is any possible confusion and to recognize the presence of any offensive or difficult questions that exist in the questionnaire. There are two methods to pretest the questionnaire. The first method is to expose the questionnaire to some expert, while the second method is to distribute the questionnaire to some IBS companies that is chosen as a sample of the pilot survey phase. The method of pretesting the questionnaire of this study was exposing it to some experts. Suggestions to improve the questionnaire were reviewed and treated respectively. After the first phase was over, the final revision of questionnaire was delivered and distributed through postal mail, e-mail and by hand. The data that have been gathered on IBS in Malaysia was processed and analyzed using Statistical Package for Social Science (SPSS) software program for Windows.

4.2 Sampling Design

The population of this study was the IBS manufacturers, consultants and contractors companies which have been gained from IBS supply chain directory 2009 (from IBS Center website). To obtain more accurate results, the sample of this study included all the population (357 companies which contain 53 manufacturers companies, 28 consultants companies and 276 contactors companies).

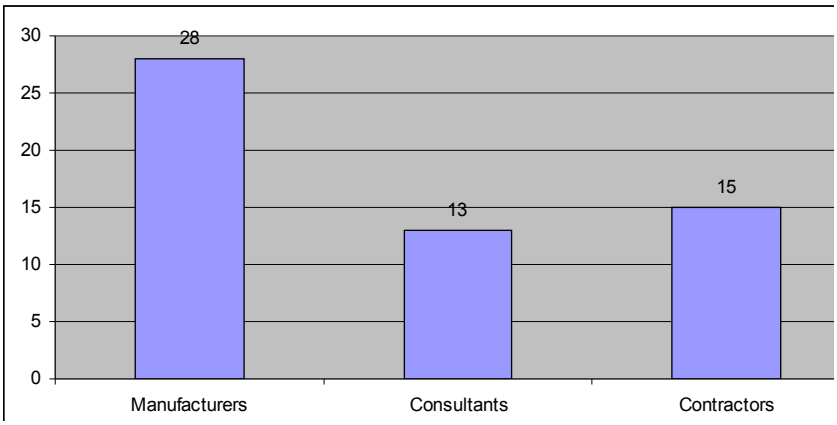
DATA ANALYSIS

The data collected from the respondents through the questionnaires was analyzed precisely.

5.1 Responses' Rate

The respondent companies were 57 companies (15.966% of the total companies) which include 28 manufacturing companies, 13 consulting companies and 15 contacting companies. The responses rate of manufacturers was 52.8% from all IBS manufacturers registered in IBS supply chain directory 2009. For consultants, the responses rate was 46.4%. While only 5.43% from all IBS contractors responded the questionnaire. It can be noticed the high responses rate for manufacturers and consultants constantly, while the responses rate of contractors was very low. The reason of this difference of response rate could be that the manufacturers and consultants viewed the survey as an advertisement tool, while the contractors viewed the survey as not valuable to add it to their busy work day. Figure 1 indicates the responses' rate.

Figure 1: Responses' rate.

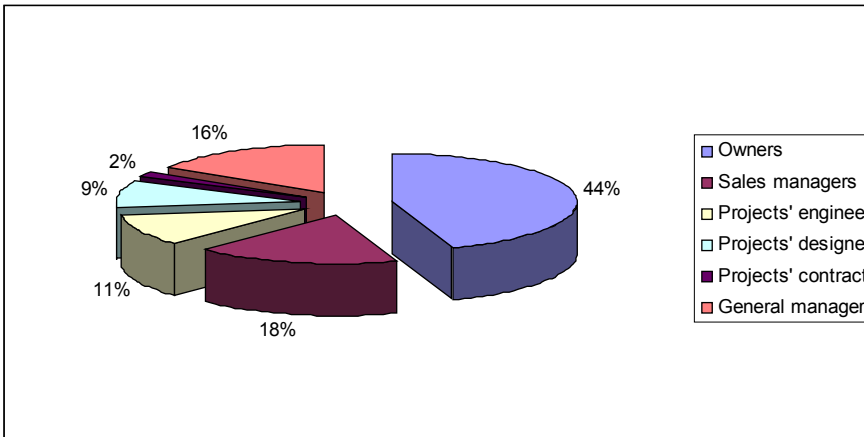


5.2 Respondents' Background:

5.2.1 Respondents' position in their companies

A total of 57 companies who responded the questionnaires, 44.6% of them were companies' owners, 17.9 % were sales managers, 16.1% were general managers, 10.7% were projects' engineers, 8.9% were projects' designers and 1.8 % were projects' contractors. Figure 2 indicates the percentage of respondents' position in their companies.

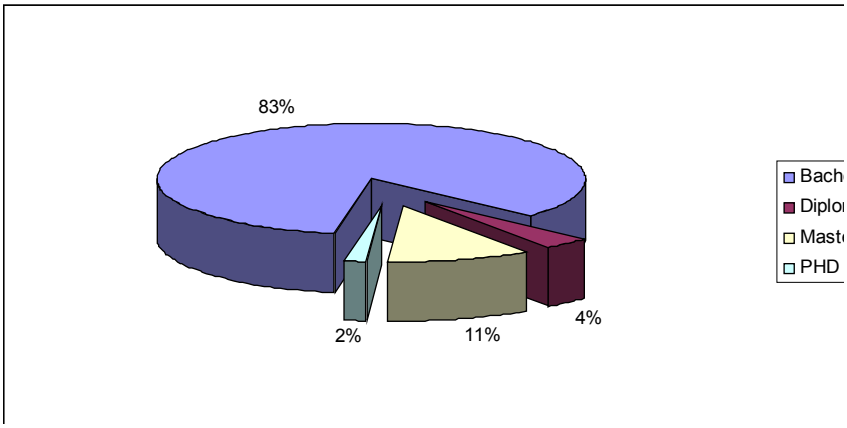
Figure 2: Percentage of respondents' position in their companies



5.2.2 Respondents' highest qualification

From all respondent companies, 83% of them got bachelor degree in their specialization, 4% of the respondents have achieved diploma in the related field, 11% of them achieved master and 2% of them achieved PhD. The highest academic qualification of respondents can be presented in Figure 3.

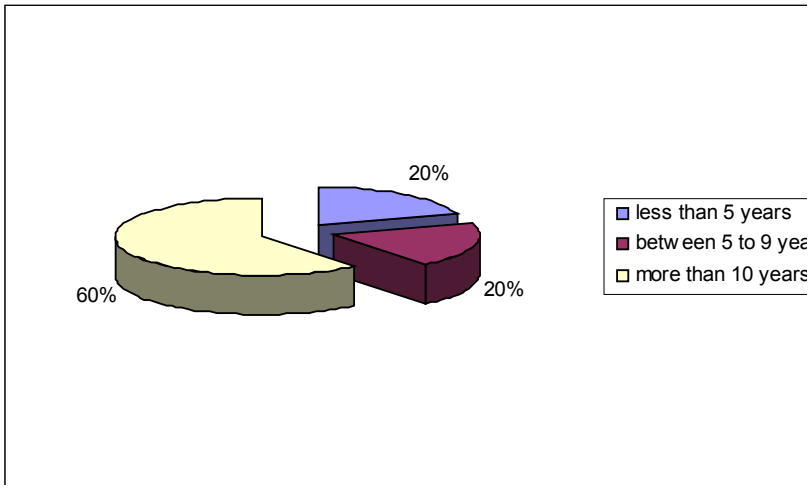
Figure 3: Highest academic qualification of respondents



5.2.3 Companies' working experience

The greatest portion (60%) of companies have experienced industrialized building system for more than 10 years. 20% have experienced IBS between 5 to 9 years, and also 20% have experienced IBS for less than 5 years.

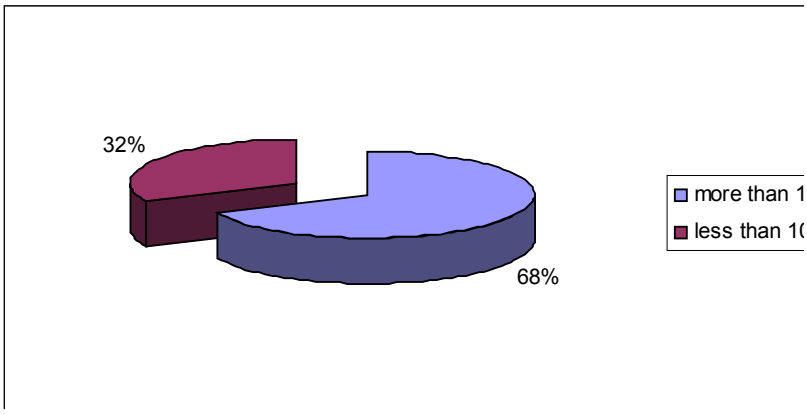
Figure 4: Companies' working experience



5.2.4 Number of IBS projects

By referring to Figure 5, it is noticed that 68% of the respondents have experienced more than 10 IBS projects. On the other hand, 32% have experienced less than 10 projects.

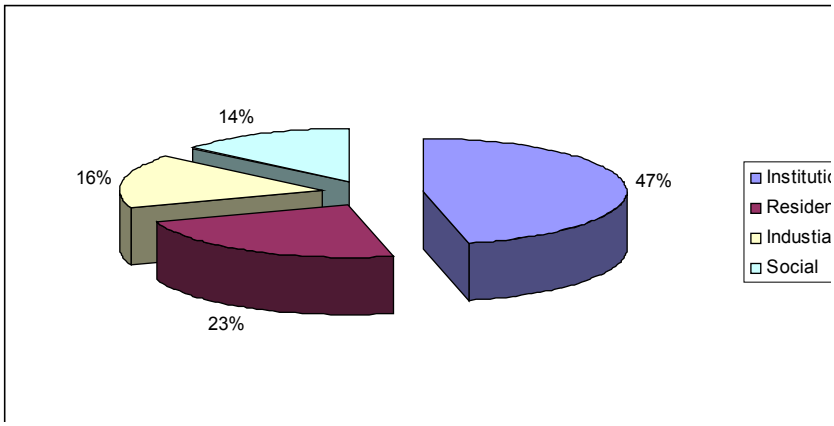
Figure5: Number of IBS projects



5.2.5 Types of IBS projects

By referring to Figure 6, it is noticed that the most common IBS projects are institutional projects (47%), followed by residential projects (23%), industrial projects (16%) and social projects (14%).

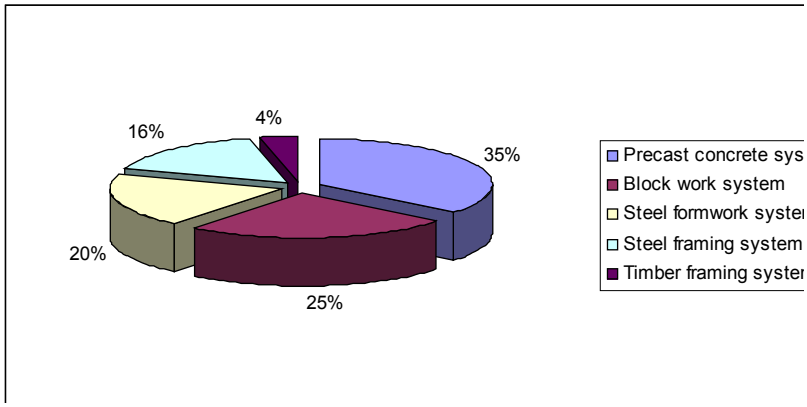
Figure6: Types of IBS projects



5.2.6 Popular types of IBS components

The results of this survey showed that the most popular type of industrialized building system is precast concrete system (35%), followed by block work system (25%), steel formwork system (20%), steel framing system (16%) and timber framing system (4%).

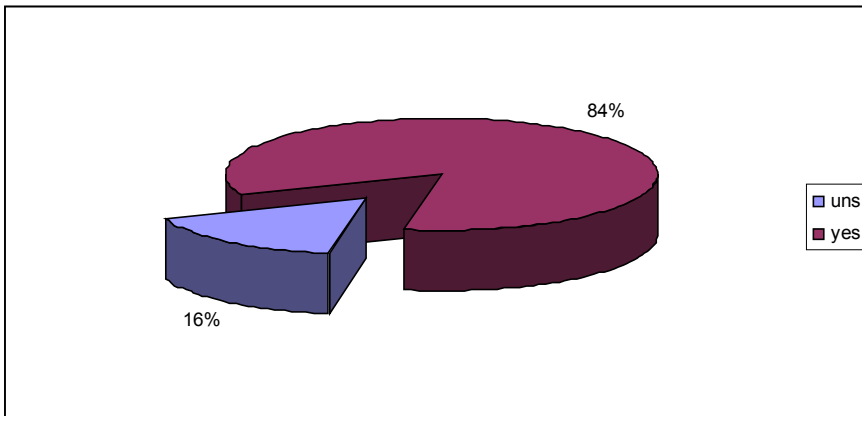
Figure7: Types of IBS components



5.2.7 Intention to continue using IBS in future

The respondents were asked whether their companies have intention to continue using IBS in future work. Figure 7 illustrates that 84% of respondents showed their agreement to continue using IBS in future while 16% were unsure. From this finding, it can be expected that using IBS will increased in Malaysian construction future.

Figure7: Intention to continue using IBS in future



5.2 Survey Findings

First of all, the data of this study have been tested to probe its consistency by applying reliability test. As Cronbach's Alpha = 0.943 (close to the value 1) for 63 items, therefore, the data has good internal consistency.

The constraints of industrialized building system which have been collected from literature reviews and suggestions from IBS experts during the pilot survey phase have been categorized under 11 main categories: lack of experience, time problems, technical problems, transportation problems, cost problems, aesthetical problems, storage problems, assembly problems, payment problems, supply chain management problems and production problems. The respondents identify variables that they perceived by responding to a scale from 1 (strongly disagree) to 5 (strongly agree). The five rating Likert Scale is, 1 = strongly disagree, 2 = disagree, 3 = neutral,

4 = agree and 5 strongly agree. Mean of each factor have been calculated and the ranking of these factors has been done to determine the most critical constraints of IBS in Malaysia.

Table 1. Constraints of IBS in Malaysia

Factors	**Mean**	**Standard deviation**	**Category ranking**	**Overall ranking**
1-Lack of experience:				
Academic curricula in universities and institutes provide inadequate education about IBS	4.34	.815	1	1
Shortage in academic curricula to educate modular coordination principles	4.30	.872	2	2
Architects are unfamiliar to design IBS projects	3.82	.636	5	10
Architects are unfamiliar to design in modular coordination principles	3.84	.682	4	9
weakness in engineers' experience to design IBS projects	3.45	.952	10	22
Non-existence of special managers to manage IBS projects	3.79	.803	6	11
Shortage of contractors' experience to handle IBS projects	3.96	.713	3	8
Workers didn't experience working in IBS projects	3.73	.798	8	14
Lack of experience to handle software systems (CAD system)	3.52	.934	9	20
Lack of scientific information about the economic benefits of IBS	3.77	.831	7	12
Lack of research and development to improve using local materials	3.79	.847	6	11
2-Time problems:				
Delay in completing the total design at expected time	3.21	1.317	4	29
Delay in deliver IBS components at exact time	3.68	1.162	3	16
Need to change the design of the project after beginning work at site	3.84	1.058	1	9
Delay in making decisions	3.32	1.097	5	27
Weak communication between projects' operators	3.73	.820	2	14
Complexity in design characteristic	3.18	.936	6	30
3-Technical problems:				
Joints are inadequate to our environment	2.70	1.043	2	40
Materials are inadequate to our environment	2.13	1.129	6	53
Shortage in special equipments at construction site	2.38	.885	4	47
Shortage in special equipments at factory	2.43	.871	3	45
Inability of IBS components to repair	3.38	1.001	1	24
Thermal expansion problems in IBS components	2.34	.959	5	49
Leakage of IBS components in earthquakes	2.04	1.095	7	54
4-Transportation problems:				
Obstructions of transportation regulations to transport IBS components	2.55	.933	2	43

Traffic accidents during transportation process	2.23	.934	4	51
Long distance between factory and site	3.54	1.095	1	19
Difficulty to reach to construction site	2.41	.949	3	46
Difficult site topography	2.04	.687	5	54
5- Cost problems				
High initial cost to establish a factory	4.13	.955	2	5
Need more money to import specific materials	2.55	1.025	11	43
Need more money to import specific equipments	2.68	1.029	10	41
High transportation cost	.986	3.71	4	15
Don't use all the allowable capacity of lorries to transport IB components	3.57	.931	6	18
Need more money to employ skilled workers	3.48	.894	7	21
Need more money to establish adequate storage area	3.30	.989	8	28
Swing of markets demands	3.63	.906	5	17
Lack of incentive and promotion from government	3.75	.977	3	13
Using expensive finishing materials in design	3.09	1.116	9	32
Cheapness of unskilled workers	4.23	.426	1	3
6- Aesthetical problems				
IBS is not attractive choice to clients	2.80	1.086	2	37
Architects don't like to design in IBS and MC methods	3.32	1.081	1	26
Boredom in IBS projects because of repetitiveness	2.41	.890	5	46
Inability of IBS method to be modern	2.52	.953	4	44
IBS method limits architectural creativity	2.61	1.056	3	42
7- Storage problems				
Shortage of storage space in factory	2.82	1.177	4	36
Shortage of storage pace at site	3.36	1.086	2	25
Storage area is exposed to environmental effects	2.80	1.135	5	37
Storage area obstructs construction process at site	3.84	1.304	1	9
Early delivery of IBS components to construction site	3.07	1.076	3	33
8- Assembly problems				
Leakage in IBS components after assembling	2.32	.936	4	50
IBS components are incompatible with each others	2.21	.948	5	52
Shortage in special machines to assemble IBS components	2.36	1.135	3	48
Shortage in specialist workers to assemble IBS components	2.70	1.060	2	40
Assembly process is expensive	3.13	1.145	1	31
9- Payment problems				
Conventional payment method is not suitable for IBS	4.05	1.086	3	7
Delay in payment from clients	4.11	1.039	2	6
Lack of client payment experience in	4.16	.848	1	4

similar project				
10- Supply chain management problems				
Don't deliver the exact number of IBS components	3.79	1.217	1	11
Project operators don't organize periodic meeting between them	3.73	.981	2	14
11- Production problems				
Ambiguity in IBS components design	2.89	1.186	3	35
Production process is slower than real need at site	2.95	1.052	2	34
Need specific machinery in factory	2.79	1.022	4	38
Need to skilled craftsmen in a factory	2.71	1.074	5	39
Lack of manufacturer	3.43	1.412	1	23

5.3 The First Ten Constraints of Industrialized Building System in Malaysia

From the variables that have been categorized under 11 categories which were ranked according to their means, the first ten variables were determined and shown in Table 2. There are 13 variables fell into the 10 top-ranking factors because of the same mean of some variables.

Table 2. The first ten constraints of IBS in Malaysia

Factors	Mean	Standard deviation	Category ranking	Overall ranking
Academic curricula in universities and institutes provide inadequate education about IBS_	4.34	.815	1 Lack of experience	1
Shortage in academic curricula to educate modular coordination principles (MC)	4.30	.872	2 Lack of experience	2
Cheapness of unskilled workers	4.23	.426	1 Cost problems	3
Lack of client payment experience in similar project	4.16	.848	1 Payment problems	4
High initial cost to establish a factory	4.13	.955	2 Cost problems	5
Delay in payment from clients	4.11	1.039	2 Payment problems	6
Conventional payment method is not suitable for IBS	4.05	1.086	3 Payment problems	7
Shortage of contractors' experience to handle IBS projects	3.96	.713	3 Lack of experience	8
Need to change the design of the project after beginning work at site	3.84	1.058	1 Time problems	9
Storage area obstructs construction process at site	3.84	1.304	1 Storage problems	9
Architects are unfamiliar to design in modular coordination principles	3.84	.682	4 Lack of experience	9
Architects are unfamiliar to design IBS projects	3.82	.636	5 Lack of experience	10

DISCUSSION

The first ten constraints of industrialized building system in Malaysia are shown in Table 2. Shortage in academic curricula to provide adequate education about IBS is the main constraint in Malaysia, followed by shortage in academic curricula to educate modular coordination principles (MC). The academic curricula in universities and institutes have to be improved to enable the new architects, engineers, contractors and other specializations to be more familiar with IBS and MC and to achieve the fully industrialization in construction sector. Cheapness of unskilled workers is the third critical constraint that encounters IBS in Malaysia. Because of this constraint, many contractors prefer to use conventional method in spite of its limitations. This study has found that there is a lack of client payment experience in similar project. Therefore, there is a delay in payment from clients in IBS projects. This may because the clients used to pay in batches for conventional method which is not appropriate in IBS projects.

This study has also found that establishing IBS work needs high initial cost. From the construction participants' view, it is so perilous to invest large amount of money in setting up IBS factory, supplying machineries and moulds and employing skilled and semi-skilled workers. There fore, role of the government to provide the initial cost to investors who want to establish IBS factories becomes very considerable. However the government is providing incentives and promotions, they are not enough and they have to be increased. Lack of contractors' experience to handle IBS projects is one of the critical constraints that encounter them to enter this field. Need to change the projects' design after beginning work at site is another critical constraint that may cause delay in IBS projects. Also, the storage area that is needed to store IBS components at site may obstruct construction process. To overcome this constraint, just-in-time principle has to be applied in construction industry. This study has also illustrated that the architects are unfamiliar to design IBS projects and modular coordination principles. This is an expected result for the shortage in IBS and MC courses in universities and institutes. When the students graduate, they prefer to design in conventional method as they experienced in their studying years.

1. CONCLUSIONS

The objective of this study was to determine the main constraints that facing the application of industrialized building system in Malaysia and propose suggestions and recommendations to improve them. Questionnaire forms were distributed to IBS manufacturers, consultants and contractors companies to collect their responses about this issue. From the findings, it could be concluded that the main constraints of industrialized building system in Malaysia are shortage in academic curricula concerning IBS and MC principles, cheapness of unskilled workers, lack of client payment experience in similar project, high initial cost to establish a factory, delay in payment from clients, conventional payment method is not suitable for IBS, shortage of contractors' experience to handle IBS projects, need to change the design of the project after beginning work at site, storage area obstructs construction process at site, architects are unfamiliar to design in modular coordination principles and IBS projects.

The role of the government becomes more imperative to solve these constraints to cope with the global construction industry.

2. RECOMMENDATIONS

The authors have proposed some recommendations to improve the application of IBS in Malaysia. These recommendations are as follows:

1- Improving the educational curriculum in universities and institutes concerning industrialized building system (IBS) and modular coordination (MC) principles.
2- Improving research and development process in universities, institutes and research centers to use local materials instead of importing them from other countries to reduce the total cost.
3- Increasing the awareness of the benefits of IBS among people.
4- The government must be serious in providing initial capital cost to developers.
5- Adopting low cost housing projects by the government.
6- Adopting intensive training courses for IBS manufacturers, engineers, architects, contractors and workers.
7- Standardization of IBS components and their joints must be applied.
8- Legislating regulations to limit the total number of foreign workers who enter Malaysia every year.
9- Legislating penalties for suppliers if they deliver IBS components later or earlier than the contractors' demands to construction site.
10- Improving the application of open building system.
11- Applying quality supervision from the government in IBS factories.
12- Good managing of construction time which will enhance cost saving.
13- Increase the production of IBS components to enrich the markets and reduce their cost.
14- Using CAD system to help architects to design IBS projects.
15- Good communication between related parties must be achieved.

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