ANALELE UNIVERSITĂȚII
"EFTIMIE MURGU" REȘIȚA
ANUL XX, NR. 3, 2013, ISSN 1453 - 7397

Nurul Rezuana Buyung, Md Azree Othuman Mydin, Abdul Naser Abdul Ghani

Investigation on Prefabricated Building System Skilled Component Installers

In the face of an increasingly challenging era of globalization, skills and new equipments which includes prefabricated building components, known as Industrialized Building System (IBS) has been introduced towards achievement of sustainable construction. IBS is a construction system in which the components are manufactured in a factory, on or off site, positioned and assembled into complete structures with minimal additional site work. IBS requires high construction precision and needs a higher skill level of workers. Compared to the conventional construction method, the skill level of IBS workers is more demanding. Although there are a lot benefits in implementing IBS, the construction industry still not rapidly implementing IBS. The IBS method still considered new and even though there are a lot of benefits it still faces barriers. In an IBS construction, the role of the contractor is shifted from a builder to an assembler on the site. Therefore, this requires the contractor to be prepared technologically with IBS knowledge and skills. It is generally perceived that the number of skilled IBS installers in Malaysia is still low even though the system has been implemented for a long time. This research is carried out to find out whether the existing number of IBS installer is sufficient. Primary data was collected by carrying out interviews with the contractors at the IBS construction site in Penang Island in order to get the contractor's feedback regarding this issue. Meanwhile, the secondary data was collected from government agencies to get the number of existing IBS installer and the number of IBS projects done in government projects. The results from this study indicated that not all categories of skill workers are in shortage. However, the number of precast concrete installer is in a critical shortage.

Keywords: *prefabricated, industrialized building system, building component, contractor, skilled worker, installer*

1. Introduction

Malaysian construction sector has contributed 4.6% of the Gross Domestic Product (GDP) in year 2011 with a total value of RM 21,370 million for that year. This shows an increase of 24.62% from the year 2005 which amounted to RM 16,107 million (Gross Domestic Product year 2005 to 2011). In year 2012, construction sector has contributed 15.5% of the GDP consisting of 22.2% in the second quarter and 18.3% in the third quarter. In enhancing the national revenue, construction sector was the largest contributor of GDP for the third quarter of the year 2012 [1].

The importance of the construction industry can be seen from the numerous mega-projects such as Kuala Lumpur Convention Centre (KLCC), Kuala Lumpur International Airport (KLIA) and Government Administration Centre in Putrajaya that have been successfully implemented. Construction activities and other related activities are expected to increase and this will increase the importance of the contribution of the construction industry in the economy. In the face of an increasingly challenging era of globalization, skills and new equipment which includes a system was introduced, known as Industrialized Building System (IBS). This system has long been introduced by the Construction Industry Development Board (CIDB) in collaboration with the government [2].

The government has done various efforts to promote the usage of IBS. Government is formulating a comprehensive action plan targeting for the concept of IBS to be applied in 50% of private projects to be achieved by the year 2012 [3]. It is an addition to the 0.125% levy exemption incentive enjoyed now. Among the proposals being studied under the action plan is the fast approval for IBS project, providing a broader development and stamp duty exemption to IBSs' home buyers. While in government projects, the IBS concept will be expanded in the public housing projects in the capital city through the Dewan Bandaraya Kuala Lumpur [4]

Industrialized Building System (IBS) is a construction technique in which the components are manufactured in a controlled environment (on or off site), transported, positioned and assembled into a structure with minimal additional site works [5]. Application of IBS in Malaysia is divided into five types, namely precast concrete system, formwork system, steel frame system, timber frame system, blocks system and other innovative system. The usage of these types of system gives positive impact on the construction industry. The advantages of using IBS are reduction of waste material, reduction of labour on construction sites, reduction of construction materials at site, better quality control, cleaner site conditions and more organized and faster construction time as well as to maintain the clean and safe environment [6].

IBS industry in Malaysia began in the early 1960's. This is when the Ministry of Housing and Local Government of Malaysia visited few European countries and evaluate their housing development program [7]. In year 1964, the government

started their first project on IBS aiming to speed up the delivery time and build affordable and quality houses. This project was awarded to Gammon & Larsen Nielsen by using Danish System of large panel of pre-fabricated system. This project took place at Jalan Pekeliling, Kuala Lumpur in about 22.7 acres of land with seven blocks of seventeen stories flats which consists of 3000 units of low cost flat and 40 shop lots [8].

The construction industries has started to implemented IBS as a method of attaining better construction productivity and quality, reducing risk that related to occupational safety and health, reducing issues for skilled workers and dependency on foreign labour and achieving the ultimate goal of reducing the overall cost of construction. This leads to the minimal wastage in construction sites, fewer site materials, a cleaner and neater environment, controlled quality and reducing construction costs [9].

2. Problem statement

Although there are a lot benefits in implementing IBS, the construction industry still not rapidly implementing IBS. The IBS method still considered new and even though there are a lot of benefits it still faces barriers. The barriers in implementing IBS in construction are:

1. In traditional method require a more coherent structure of process planning and control from the design, manufacturer, assembly and other related processes in order to reduce defect and errors [2].
2. IBS need radical and large change from a traditional building process to a manufacturing process. The idealism, processes, management and skills in IBS method are different from the conventional method [4]
3. The large obstacle is the lack of adequate knowledge of the IBS method. There is limited of knowledge in the marketplace among the designers and contractors regarding the IBS method. Approaches to design are still based on conventional methods that are unsuited to the IBS method [5]
4. IBS method is used to address the skill shortage in the construction industry. However, there is some evidence that a skilled manpower in specific skill areas are becoming more important to IBS construction such as integration, coordination and assembly due to different roles and projects method that are carry out [6]
5. The implementation of IBS requires a new approach, investment and financial planning including an effective combination of cost control and selection of projects that give enough volume to justify the investment [4,5,6].

Migration from conventional method of construction to IBS requires new skills and knowledge. This leads to the recommendation that skilled and experienced workforces are critical to IBS. It is imperative that contractor employ appropriately skilled operators at site or enable a range of task to be undertaken by fewer but multi skilled operators [10]. Large production output and standardization of precast

elements allow a high degree of skills and fully competent personnel. The reduction of skilled labour in IBS is offset by the need to develop new skills and competencies among the IBS manpower.

Compared to the conventional construction method, the skill level of IBS workers is more demanding. Under IBS system, the demand for on-site manual labourers, particularly carpenters, bar benders and concreters become lesser. The system demands more machine-oriented skills, both on sites and in factories. This situation leads to a transformation requiring the restricting of human resource in an organization in term of education and training. Unfortunately, the skilled workers in Malaysia still low. Therefore, more intensive training programmes are needed in the in the specialized IBS skills like system integrating or assembling. However, this need requires more time and investment [5,9]

In an IBS project, the role of the contractor is shifted from that of a 'builder' to that of an 'assembler' on site. This requires contractors to be equipped technologically with IBS knowledge and skill. The needs are made more imperative if the contractors were to promote their IBS products and compete in the industry. From July to September 2002, the situation was suddenly worsened when many trained foreign workers were forced to leave the country after a wide spread crackdown on illegal foreign workers. The 'new batches' of foreign workers did not possess the required skill in IBS and had to be retrained [3].

3. Research Methodology

There are six stages of research methodology in a research which begin with the problem statements. Secondly, after determining the problem statements, the study objectives need to be determined. At the third stage of this research, studies the subject matter through literature review to produce a further understanding on the issues and challenges with skilled workers in IBS construction. At the fourth stage, data was collected through prime data and secondary data. Primary data were collected by interview and site observation at the selected site which is focused on Penang area. Secondary data was collected from Implementation Coordination Unit Prime Minister's Department (ICU PMD or ICU JPM), Construction Industry Development Board (CIDB) in Industrialized Building System Center department, journal, articles and internet sources. At the fifth phase, data have been analyzed to achieve the objective of the study. After analyzing all data collection, the final stage was making conclusions based on the analysis and findings of the study.

3.1 Determine problem statement

A problem statement is a short description of the issues that we want to study before we solve the problem. The primary purpose of a problem statement is to focus attention on solving the problem. A problem statement also is a question or statement that clearly identifies the variables under consideration for which an

answer is to be described, explained, and predicted and which is possible to test. In this research the problem statement is about issues and challenges with skilled component installers in the Industrialized Building System (IBS) construction. There are several research had been done before about construction workers such as construction skilled workers and foreign workers in Malaysia. In this research we will concern about IBS skilled workers' issues.

3.2 Determine research or study objectives

The objectives of a research project summarize what is to be achieved by the study. These objectives should be closely related to the research problem. The general objective of a study states what we expected to achieve by the study in general terms. It is possible and advisable to break down a general objective into smaller, logically connected parts. These are normally referred to as specific objectives. Specific objectives should systematically address the various research questions. In this research, the objectives that need to be achieved are present figure or numbers of IBS skilled workers and IBS project within states. The second objective is to get contractor feedback regarding to the skilled worker issues or problems. Lastly is to make recommendations to the skilled workers' issues or problems.

3.3 Literature review

Literature review had been carried out by referring to several references which are electronic journals, articles and sources from the internet. There are few research had been carried out in term of construction workers and skilled construction workers but not specific to IBS construction. It had been identified that the skills are based on the IBS categories. There are in the precast concrete system, formwork system, steel frame system, timber frame system, block system and other innovative system. Under this category it will divide into several parts of works. In order to get a real picture of research topic, an interview with the players in the IBS construction at selected site had been conducted. This research focused on Penang island area and had been found 3 sites using IBS in precast system.

3.4 Data collection

The second stage is collecting research data and this stage was the most important stage between the four stages in research methodology. This is because they resulted from the research will gain from the collected data that we have. The data were collected through literature review and interview. Data collection is divided into primary data and secondary data. Primary data means original data has been collected specially for the purpose in mind. It means someone had collected the data from the original source first hand. The first hand data are called primary data. Primary data have not been published yet and is more reliable,

authentic and objective. This data also has not been changed or altered by human beings. So that it validity is higher than the secondary data. In this research, the primary data were interviewed questionnaire at the site and site observation by the researcher.

The interview question was divided into 2 sections. The first section focused on the project background which is the contractor, engineer and owner of the project. Section 2 focused on the contractor feedback regarding the IBS installer issues or problems.

This interview only focused on the running IBS construction site in Penang island area. There are three IBS construction sites available in Penang island area which at Jalan Batu Gantung, Sungai Gelugor and Minden Height.

Secondary data is the data that has been collected by and readily available from other sources. Secondary data is cheaper and can quickly obtain than the primary data. The secondary data may be obtained from many sources including literature review, industry survey, compilation from computerized databases and information systems, and computerized or mathematical models of environment processes.

In this research, secondary data was data from about IBS construction project in year 2010 until 2013 from the Implementation Coordination Unit Prime Minister's Department (ICU PMD or ICU JPM, skilled workers data or IBS installer from Construction Industry Development Board (CIDB) in Industrialized Building System Center department, electronic journal, articles and other internet sources. This research focuses government projects.

3.5 Data analysis

Analysis of data is a process of inspecting, cleaning, transforming and modeling the data with the goal of highlighting useful information, suggesting conclusions and supporting decision making. Data analysis has multiple facets and approaches, encompassing diverse techniques under a variety of names in different business, science and social science domains. Data mining is a particular data analysis technique that focused on modeling and knowledge.

In this research, data analysis will be analyzed by comparing the pattern of IBS project for each states and ministry for year 2010, 2011 and 2012. Other than that data will be analyzed by connecting the numbers of present skilled workers which until year 2012 and future IBS projects which in year 2013. In this analysis, we will get figure regarding the skilled workers issues and answered the research question is the IBS skilled workers a problem in IBS construction. By using total present number of skilled workers (until year 2011), it will be linked with future IBS project (year 2012) and will get figure whether present number of IBS skilled workers is enough for this future IBS project or not enough or the number is excessive.

If the existing skilled workers were enough, what recommendation or comment to make sure that we have maintained it. If the existing skilled workers

were not enough or less, what recommendation to increase the number so that the skilled workers shortage problem can be solve. Lastly, if the existing skilled workers were excessive from what had required what recommendation to ensure the redundancy of this skilled workers get job or get involved in IBS construction project.

3.6 Conclusion

Conclusion summarized and brings together the main areas covered in a research or study which might be called "looking back" and secondly is to give final comment or judgments on this research or study.

4. Data Collection and Analysis

4.1 Number of IBS skilled workers or installers

The registration program for the IBS installers begins in the year of 2009 (Figure 1). There are a total number of 598 installers registered and tested for 4 IBS types. The highest number of installers is the installation of steel roof truss which are 511 people. Whereas, the precast concrete type shows the lowest number of participants with a total number of 15 people. We can see that there is a large difference number between steel roof truss and another 3 IBS types which are precast concrete, lightweight block and timber roof truss. From the total of 598 installers, 85.45% of the installers are the IBS type of steel roof truss and only 14.55% of the installers are the IBS types of timber roof truss, lightweight block and precast concrete.

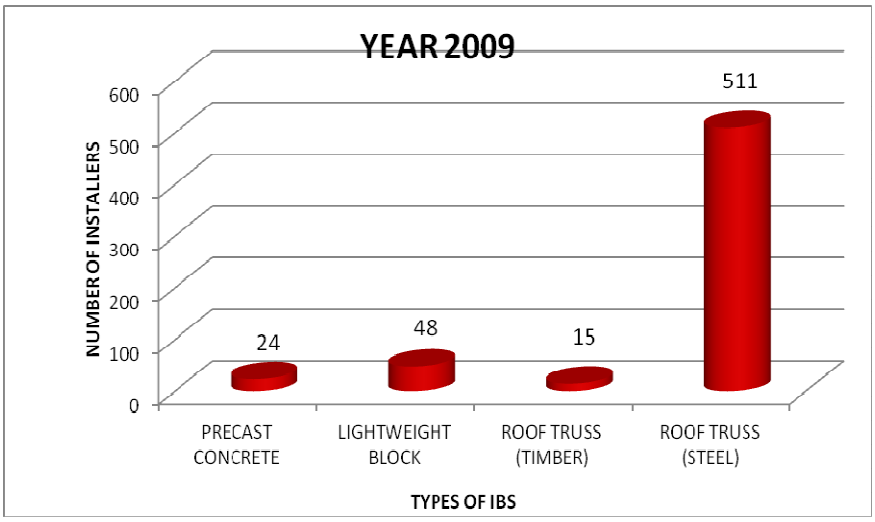


Figure 1. Number of IBS installers 2009 [11]

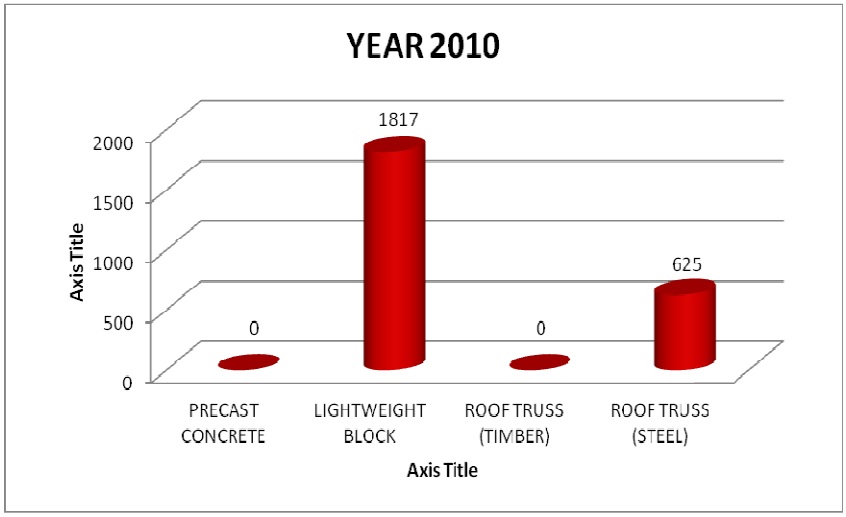


Figure 2. Number of IBS installers 2010 [11]

There are dramatic increases of installers in the year of 2010 which it increases from 598 numbers of people to 2 442 numbers of people or 308.36% from year 2009 (Figure 2). Even though the overall number of installer increases but there is no increasing numbers of timber roof truss and precast concrete installers. The lightweight block installers also show dramatic increases from 48 people to 1817 people in year the year of 2010.

In additional, the number of steel roof truss installers has increase from 511 people to 625 people. The increasing numbers of steel roof truss installers is only 18.24% compared to the increasing numbers of the lightweight block installers. However, the number of timber roof truss and precast concrete installer remain the same as there is no registered installer in the year of 2010.

Also in the year of 2011, the registration of the installers has increase to 3012 people (Figure 3). The number has increase about 23.34% from the previous year. Three types of IBS which are precast concrete, lightweight block and steel roof truss respectively show the increasing numbers of installer number. The number of lightweight block and steel roof truss installers increase from 1817 people in the year of 2010 to 1981 people or 8.28% in the year of 2011 and 625 people to 1031 people or 39.37% from the year 2010. The number of precast concrete installers has also increases from zero registered installers to 557 people. However, the number of timber roof truss installer remains the same from the year 2010.

The overall total numbers of registered installers are 6609 people (Figure 4). The total number of lightweight block installer shows the highest number compared to other IBS types with a total number of 3846 people from the year 2009 until the year 2011. This is followed by the number of steel roof truss installer with 2167 people. However, there is one large difference between the number of pre-

cast concrete installer and the lightweight block and steel roof truss. The timber roof truss shows the lowest number of installer compared to others.

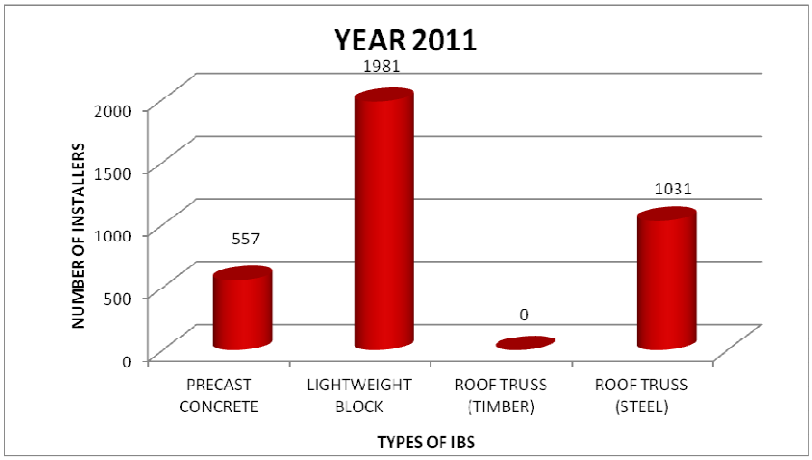


Figure 3. Number of IBS installers 2011 [11]

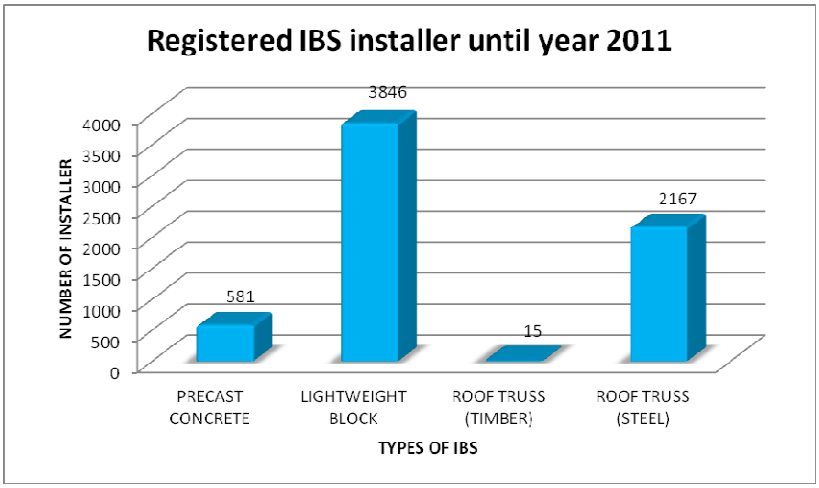


Figure 4. Overall Number of IBS installers [11]

4.2 Distribution of IBS projects

In year 2010, there were a total numbers of 331 government projects that were using the IBS method. A total number of 17 Ministries of the government were deploying IBS in their projects. The types of projects involved schools, clinics, hospitals, colleges, polytechnics, campuses, training institution, offices, hostels, technical lab, flyovers and bridges.

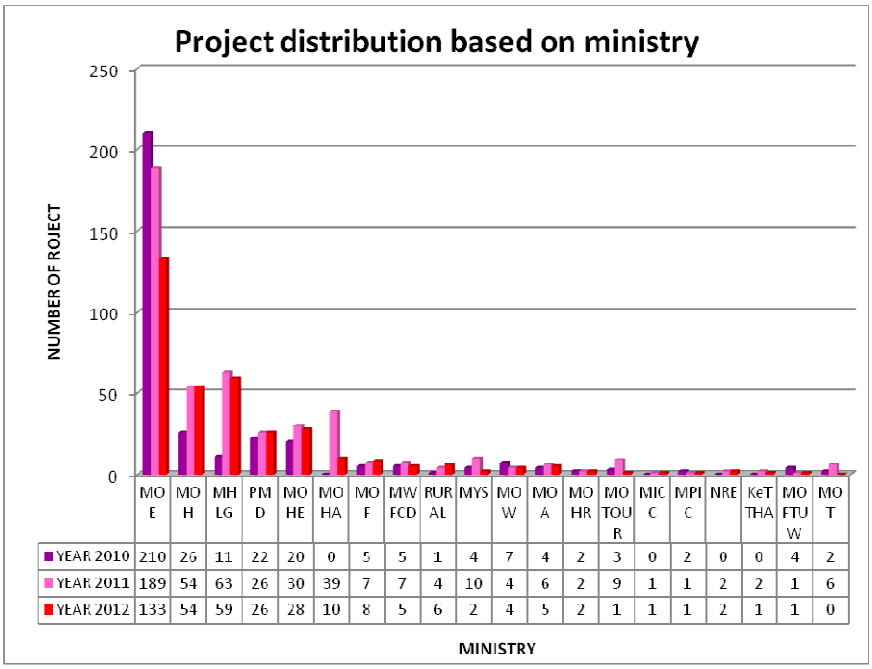
The number of IBS projects for each Ministry varies from 1 to 210 projects and the largest user was the Ministry of Education (MOE) with a total number of 210 projects. There were large differences between the numbers of projects for MOE and other ministries. This is because the second larger user was from the Ministry of Health with the total number of 26 projects only. Beside MOE, all ministries' projects were less than 50 projects. The lowest user was the Ministry Of Rural And Regional Development (RURAL) with only 1 project.

In year 2011, there were a total number of 463 government projects that used IBS method. This shows that the IBS project of the government project increased about 39.88% from the year of 2010. As the number of project increases, the number of ministry implemented the IBS method also increases. A total number of 20 Ministries of the government were deploying IBS in their projects.

The number of IBS projects for each Ministry varied from 1 to 189 projects and the largest user was the Ministry of Education (MOE). However, the total number of project for MOHE in the year of 2011 had decreased 10% from the year of 2010. Two ministries which are the Ministry of Health (MOH) and the Ministry of Housing and Local Government (MHLG) showed more than 50 projects. This shows an increasing number of projects. The lowest numbers of projects were from the Ministry of Energy, Green Technology and Water (MOFTUW), the Ministry of Information Communication and Culture (MICC) and the Ministry of Ministry of Plantation Industries and Commodities (MPIC) with a total number of one project.

While in the year of 2012, the total number of project had decreased about 24.62% compared to the year of 2011. There were a total number of 349 government projects that were using the IBS method. In year 2012, there were a total number of 19 Ministries of the government which were deploying the IBS method in their projects.

The number of IBS projects for each Ministry varied from 1 to 133 number projects and the largest user was the Ministry of Education (MOE). However, the total number of project for MOHE in year 2012 had decreased about 0.30% from the year of 2010. The lowest numbers of projects were from the Ministry of Energy, Green Technology and Water (MOFTUW), the Ministry of Energy, Green Technology and Water (KeTTHA), the Ministry of Information Communication and Culture (MICC), the Ministry of Ministry of Plantation Industries and Commodities (MPIC) and the Ministry of Tourism Malaysia (MOTOUR) with a total number of 1 project.



	MOE	MOH	MHLG	PMD	MOHE	MOHA	MOF	MWFCD	RURAL	MYS	MOW	MOA	MOHR	MOTOUR	MICC	MPIC	NRE	KeTHA	MOFTUW	MOT
YEAR 2010	210	26	11	22	20	0	5	5	1	4	7	4	2	3	0	2	0	0	4	2
YEAR 2011	189	54	63	26	30	39	7	7	4	10	4	6	2	9	1	1	2	2	1	6
YEAR 2012	133	54	59	26	28	10	8	5	6	2	4	5	2	1	1	1	2	1	1	0

Figure 5. Total number of Government IBS projects by Ministry [12]

As shown in Figure 5, it can be seen clearly that there is an increasing numbers in the number of projects for year 2011, but in the year of 2012, the number of project has slightly decreased. As a whole, almost all ministries had a declined numbers of projects in year 2012. The ministry with the largest number of projects among all the ministries is the Ministry of Education (MOE). There are only 5 ministries with more than 10 projects. Another 14 ministries have less than 10 projects. Significant difference can be seen between the number of projects by the MOE and by the other ministries

4.3 Distribution of IBS projects based on states

The same total of projects which are 331 projects from the Ministry is divided into each state in Malaysia. In year 2010, it can be seen that Selangor had the highest number of projects with 111 projects or 33.53% in Selangor. This is followed by Johor with 46 projects and the lowest number of project is Perlis with 2 projects only. It is also the same total of projects number in year 2011 which are 463 projects from Ministry and is divided into each state in Malaysia. Also in the year 2011, it can be seen Selangor had the highest number of IBS with 106 projects. Even though Selangor had the highest number of projects but the number of project had decreases from 111 projects in year 2010 to 106 projects in year 2011. This is followed by Johor with 62 projects but compared the numbers of projects in 2011 with the numbers of projects in 2010 the numbers of projects

in Johor had increased from 46 projects to 62 projects in year 2011. The lowest number of project was still in Perlis but the numbers had increased from 2 projects in year 2010 to 9 projects in year 2011.

While in year 2012, it is also the same total of projects number which is 349 projects from Ministry and it is divided into each state in Malaysia. However, in year 2012 the number of projects in Selangor and Johor are the same which are 57 projects. This shows some decreases in number of projects in Selangor which was from 106 projects in year 2011 and dropped to 57 projects in year 2012. The decreases of the projects number is almost about 50% from year 2011. The same situation also faced in Johor but not in a large number, from 62 projects to 57 projects. Also in year 2012, the numbers of projects in Perlis is still the lowest compared to others states. The decreasing numbers of projects also happened in Perlis which is from 9 projects to 5 projects.

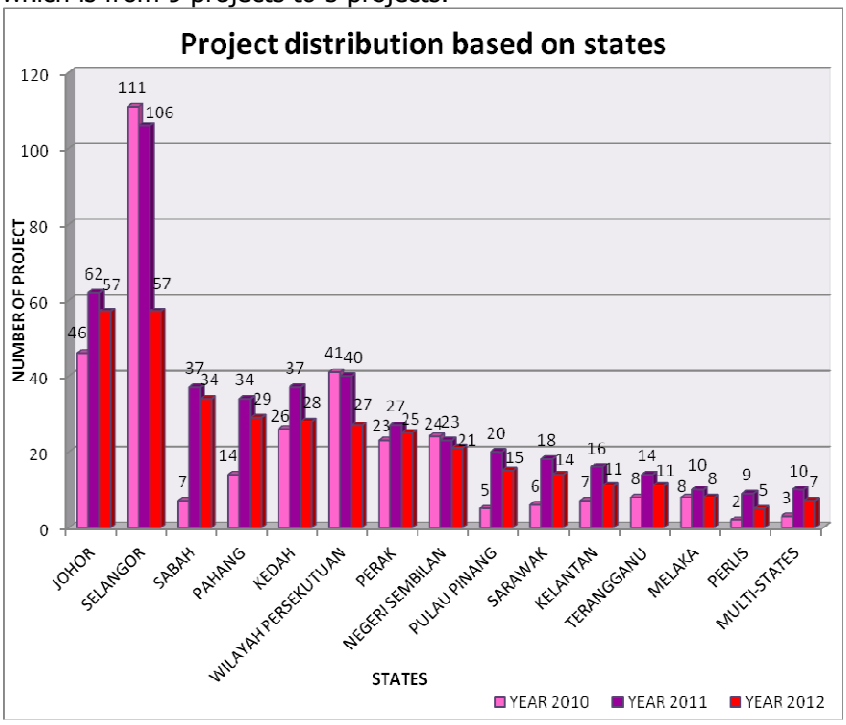


Figure 6. Total number of Government IBS projects by State

As been shown in Figure 6, it can be concluded that almost all states shown an increasing patterns from the year 2010 until the year 2011. While in the year 2011, the number of projects in all states is decreasing. The state with the largest number of projects in Malaysia is Selangor with the total number of 274 projects from the year 2010 until year 2012. This is followed by Johor with a total of 165 projects for three years. Significant difference can be seen between the number of projects between Selangor and the other states.

The state with the lowest number of project is Perlis with a total of 16 projects. There are a few states with the total of less than 50 projects which are Melaka with 26 projects, Terengganu with 33 projects, Kelantan with 34 projects, Sarawak with 38 projects and Penang with 40 projects.

One factor affecting the number of projects in Malaysia Plan (Rancangan Malaysia) is the provision for every ministry given in Malaysia Plan. For year 2010 the provision is under Ninth Malaysia Plan (Rancangan Malaysia ke-9) while year 2011 and 2012 are under Tenth Malaysia Plan (Rancangan Malysia ke-10). Every ministry is given its provision and based on the provision given by the government; all the ministries are divided based on their requirements. If they have a plan for a construction requirement such as building an office or school, the provision will be distributed according to the states.

5. Site Observation

5.1 Case study 1 – School project

This project consists of one block of four-storey building which is for administration and academic block (Block A) and one block of two-storey building for science laboratories (Block B). This project used IBS method in term of precast concrete. They used two IBS component specialists that are from Creative Precast Technics Sdn. Bhd. for beams, half slabs and stairs and Acotec Wall Panel for wall panel as been shown in Figure 7.

From the interview sessions, this project was experiencing a shortage of installers. The problem occurs when there is a project nearby using the same IBS specialists. When the project nearby was facing a delay in their construction, the same IBS specialists took a few skilled installers from this project to do critical works on that project. This has caused a shortage of skilled installer for this site and the installation works to be delayed.

5.2 Case study 2 – School project

The development project is for the amendments and additions of building works for a building of classrooms and administration offices of four-floor building (Block A), the amendments of four-storey academic block (Block B) and a bus stop barrier or wall, the amendment or addition of one-storey kindergarten block (Block D) and refurbishment of a block of two-storey building to Sekolah Kebangsaan Sungai Gelugor, Pulau Pinang. This can be summarized that the project consists of development and amendments works for four school blocks.

This project used IBS type of precast concrete. They used two IBS component specialists that are from Creative Precast Technics Sdn. Bhd. for beams, half slabs and stairs and Acotec Wall Panel for wall panel as been shown in Figure 8. These are the same specialists from the Case Study 1.

From the interviews, this project had never experienced a shortage of installers. There is no problem occurring during the construction even though there

is a project nearby using the same IBS specialists. However, they have experienced a delay in their project and needed to use two teams of installer and have to rent another crane in order to cover their delay.

Figure 7. Examples of half slab and stair installed on site

Figure 8. Examples of wall panel and beams installed on site

6. Conclusion

Results from this study found that the number precast concrete installers encounter a critical shortage of installers. This is because the total number of existing installers can only accommodate a small number of projects which is 166 projects or 18% of the total projects. In addition, the timber roof truss installer also having a critical shortage of installers but it can be replaced by the steel roof truss because the number of steel roof truss installers is enough. For the number of lightweight block installer is more than enough. In conclusion, there will be a high demand on precast concrete installer. Hence, the parties responsible for the supply of precast concrete installers should play a role in reducing the precast concrete installers' shortage. To get a better quality of installation they need to use skilled installer and using skilled precast installer would avoid the undesirable things happen such as mistakes in assembling components, jointing and others. The government can take initiative to provide more IBS training centre because current training centers are limited based on region and also promote IBS system widely such as IBS road show, exhibition and talks which is not only focus at the region. Further studies may be conducted to further explore on the difficulties encountered on the installers as well as the percentage of local and foreign skilled IBS installers. This is because based on the strategies outlined in the IBS Roadmap 2003-2010 is including a reduction in the number of foreign workers in the construction industry in stages.

Acknowledgement

The authors would like to thank Universiti Sains Malaysia and Ministry of Higher Education Malaysia for their financial supports under Fundamental Research Grant Scheme (FRGS). No. 203/PPBGN/6711256.

References

[1] Hamid Z., Kamar K.A.M., Zain M., Ghani K., Rahim, A.H.A., *Industrialized Building System (IBS) in Malaysia: the current state and R&D initiatives*, Malaysia Construction Research Journal, 2(1), 1-13, 2008.

[2] Trikha D.N., *Industrialised building systems: Prospects in Malaysia*, Proceeding of World Engineering Congress 1999: Industrialised Building Systems and Structural Engineering, Serdang. Universiti Putra Malaysia, 1999.

[3] Hamid Z., Kamar K.A.M., Zain M., Ghani K., Rahim, A.H.A., *Industrialized Building System (IBS) in Malaysia: the current state and R&D initiatives*, Malaysia Construction Research Journal, 2(1), 1-13, 2008.

[4] Badir Y.F., Kadir M.R.A., Hashim, A.H., *Industrialised Building Systems Construction in Malaysia,* Journal of Architectural Engineering, 8 (1), 76-84, 2002.

[5] Nawi M.N.M., Lee A., Nor K.M. *Barriers to Implementation of the Industrialised Building System (IBS) in Malaysia*, The Built & Human Environment Review, 4 (2), 34-37, 2011.
[6] Warszawski A. *Industrialized and Automated Building System*, Technion-Israel Institute of Technology, E & FN Spoon, 1-12, 1999.
[7] Thanoon W.A.M. *The Experiences of Malaysia and other countries in industrialised building system*, Proceeding of International Conference on Industrialised Building Systems, Sep. 10-11 Kuala Lumpur, Construction Industry Development Board Malaysia, 42-51, 2003.
[8] Kamar K.A.M., Alshawi M., Hamid, Z., *Barriers to industrialized building system (IBS): The case of Malaysia*, BuHu 9th International Postgraduate Research Conference (IPGRC) (Eds., Alshawi, M., Ahmed, V.,Egbu, C. and Sutrisna, M.), Salford, United Kingdom, 471-484, 2009.
[9] Lew Y.L., *Factors contributing to cost control problems in Malaysian IBS construction*, Proceeding of International Conference on Industrialised Building Systems, Sep. 10-11, Kuala Lumpur. Construction Industry Development Board Malaysia, 143-154, 2003.
[10] Kamar K.A.M., Alshawi M., Hamid Z., *Barriers to industrialized building system (IBS): The case of Malaysia*, BuHu 9th International Postgraduate Research Conference (IPGRC) (Eds., Alshawi, M., Ahmed, V.,Egbu, C. and Sutrisna, M.), Salford, United Kingdom, 471-484, 2009.
[11] CIDB *Industrialised Building System (IBS): Implementation Strategy from R&D Perspective*. Kuala Lumpur: Construction Industry Development Board Malaysia, 1-13, 2009.
[12] IBS Roadmap 2003-2010, *Construction Industry Development Board* (CIDB), Kuala Lumpur, 2003.

Addresses:

- Nurul Rezuana Buyung, Building Technology graduate, School of Housing, Building and Planning, Universiti Sains Malaysia , 11800, Penang, Malaysia, nrezuana.uhbp10@student.usm.my
- Senior Lecturer Md Azree Othuman Mydin, School of Housing, Building and Planning, Universiti Sains Malaysia , 11800, Penang, Malaysia, azree@usm.my.
- Senior Lecturer Abdul Naser Abdul Ghani, School of Housing, Building and Planning, Universiti Sains Malaysia , 11800, Penang, Malaysia, anaser@usm.my