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Potential Implementation of Green Prefab System in Malaysian Construction Industry

Prefab system can be defined as a building process in which sections of modules of the structure are assembled at a remote location, and then transported to the construction site. This type of construction technique is very lucrative and often makes it possible to complete a building project in as much as half the time required for more traditional methods. Prefab construction is frequently employed with the construction of new houses; the strategy can also be used with other buildings. The outstanding ability behind prefab construction is based on the idea that by using standard components that are partly assembled on a manufacturing floor, there is less time involved in the actual construction process. The modules are transported to the site, using freight transportation. At the site, the modules are unloaded, moved into position with the aid of heavy machinery, and connected to form a single building. Along with the fast assembly, prefab construction could often save a great deal of money on the building construction. By using standard patterns, the building materials are pre-cut at the manufacturing site. This eliminates an enormous deal of the waste in timber and other components that can crop up during the process of building. Consequently, a prefabricated house with three bedrooms is likely to cost significantly less than a three bedroom dwelling that is constructed from scratch at the building site. This paper will discuss the potential of green prefab construction in Malaysia.

***Keywords**: prefabrication, green technology, standard components, precast, traditional construction, modular system*

1. Introduction

The prefab system can be generally described as a construction system in which all building components are mass produced. The prefab system can either be utilised at a factory or on an on-site factory, according to the specifications that

have been set to standardise the shapes and dimensions of the components used. These components will then be transported to the construction site, where they can be rearranged according to certain standards before they are cleared to be used to form a building [1].

The development of the prefab system is common knowledge in the construction industry. The history of prefab in UK housing dates from the mid-1900s, when this and other forms of prefabricated construction were used to address the problem of widespread destruction of housing stock during the Second World War.

In the United States, the use of precast in the construction industry began with the construction of the prefabricated steel house by General House in 1930. However the early efforts of rationalising and implementing such methods faded quickly due to price in-competitiveness, high capital and inconsistent local codes. The use of precast increased sharply after the Second World War due to the need to resolve critical shortage of houses.

The prefab concept had been introduced in Malaysia in 1966, in which the Malaysians used their own concept that used precast concrete building. During that year, the government launched two pilot projects for precast housing which involved the construction of Tuanku Abdul Rahman Flats in Kuala Lumpur and the Rifle Range Road Flats in Penang [1]. Both projects were the firsts of their kind, whereby precast elements were used to construct mass houses. Then, Perbadanan Kemajuan Negeri Johor (PKNS) had imported the precast concrete technology from Germany. It was used for construction projects involving low cost housing and luxurious housing, such as bungalows and semi-detached houses [2].

Currently, there are many private companies in Malaysia that have joint ventures in implementing prefab system with foreign experts from developed countries such as Australia, Netherlands, United States and Japan. One of the main reasons for doing so is to explore the possibilities of precast solutions to their projects. Numerous construction projects have utilised precast components that can help a project to work under the time constraints while still maintaining high accuracy and quality. The prefab components are commonly used in the construction of schools, colleges, quarters, apartments, hospitals, roads, port and other infrastructures [2].

Despite its history in Malaysia, the usage of prefab in buildings in Malaysia is still low compared to developed countries such as Europe, United States and Japan. The Construction Industry Development Board (CIDB) Malaysia conducted a survey from which they discovered that the level of usage of the prefab system in the local construction industry is at 15% based on the prefab system Survey in 2003 [1,2,3]. The main barriers that impede the growth of prefab system are the resistance from the parties involved in the construction and the local authorities who are generally unwilling to make changes in local building regulations. They require time, work and cost to establish the legislative, structural planning and economic conditions for industrial development. The developers have to plan a larger project scheme, which is part of the way to reduce the costs of houses for

economic viability. In this sense, the contractor will relatively play a less important role because the precast manufacturer will take the bulk of the responsibility [3].

Moreover, the subcontractors who rely on labour will be out of business due to the fact that prefabrication will reduce the number of workers, as this method is heavily-dependent on machines. However, the Malaysian construction industry needs to evolve in-line with this globalised era, and prepare itself for an industry where an increase in productivity, quality and safety is a must [2].

It seems that examples of successful implementations of such an established manufacturing process have not been fully appreciated by the local construction industry. Maybe a greater intervention from government linked companies (GLCs) is needed to set up the mega housing projects and to provide an endless supply of ready-made components for buildings by multiple vendors and suppliers [3].

2. Benefits and Current Matters of the Prefab System

2.1 Benefits of Prefab System

The conventional construction methods have been proven to be wasteful, dangerous and messy. These are evident throughout the entire process of building construction. The Malaysian construction industry needs to implement methods that will help it evolve and prepare for a globalised era. The methods selected are used to increase the productivity, quality and safety, which all are compulsory elements in the construction process, while not forgetting to reduce the cost and construction period. As such, the advantages of using the prefab system are:

- Reduction of unskilled workers
- Reduce wastage
- Increase in quality
- Safer working environment in construction sites
- Reduce construction period

The Malaysian construction industry depends on unskilled foreign workers, for example from countries such as Indonesia, Bangladesh, and Vietnam. The absence of foreign workers during the Amnesty Programme launched by the government in 2005 have crippled most of the construction projects throughout Malaysia. This can hinder the development in this country and it can cause huge losses in term of cost especially to the local developers and contractors [4].

By implementing the prefab system, the number of unskilled foreign workers in this country can be reduced. As a result, the country does not need to spend money to import these foreign workers into this country, which will positively benefit the economy. With less labour involvement, the prefab system will also reduce the overall duration of a construction process. This allows the constructor to save on overhead costs. Worker congestion on-site can also be avoided, as several crews of workers such as concreters, brick layers, plasterers etc., do not need to be working in close proximities at one time. In fact, by using the prefab system

method, the services of the concreters, plasterers, brick layers and carpenters will no longer be needed on-site, but in the prefab system factory [4].

During construction, the conventional construction methods normally generate about 20% of wastage in terms of cost. The usage of prefab system elements eliminates or greatly reduces conventional timber formwork and props. This reduction will minimise the use of timber and the forest can be saved from destruction [5]. It can reduce the usage of nail for the conventional formwork. Moreover, the elements produced in the plant and mostly designed to be repetitive and thus minimal wastage will be experienced at the factory and construction site.

The prefab system elements are manufactured in a shaded and environmentally protected casting area where critical factors including curing temperature are taken into account. The temperature control is important to prevent structural cracking as it can avoid weather related delays. The concrete mix design and stripping time can be controlled and monitored closely or accelerated either using additives or steam curing. This will ensure that the qualities of the precast products are better than the cast in situ concrete [3].

The prefab products in the market provide a safe working platform for workers to work on. Prefabricated elements will greatly reduce the usage of nails and bricks. They are the main causes of construction-related accidents in the country. The reduction of workers will enable workers to work at ease without much congestion involving several groups of workers at the same time. Using the conventional construction method, brick laying is started as soon as the strip before it was completed. However in some cases, the bricks will arrive on-site before in their strip forms. This will lead to congestion between the carpenters and the brick layers and thus the workers face risks of falling formwork [4].

The prefab system construction will save valuable time and helps to reduce the risk of project delay. While the construction site is under survey or earthwork, the design and production of elements can be started .The production of the prefab system elements are not affected by weather conditions due to the controlled environment of the casting area. The usage of large structural panels speed up the structural works and thus other trades such as painting, electrical wiring and plumbing works can begin work after that. The average delivery time for a complete house using the prefab system construction method is approximately 3 to 5 months whereby the conventional system takes about 18 months to complete [5].

2.2 Current Matters Related to Prefab System

The most widely-used form of prefab in building and civil engineering is the use of prefab concrete and prefab steel sections in structures where a particular part or form is repeated many times. It can be difficult to construct the formwork required to mould concrete components on site, and delivering wet concrete to the site before it starts to set requires precise time management. Pouring concrete sections in a factory brings the advantages of being able to re-use moulds and the

concrete can be mixed on the spot without having to be transported to and pumped wet on a congested construction site [7]. Prefabricating steel sections reduces on-site cutting and welding costs as well as the associated hazards.

Prefabrication techniques are used in the construction of apartment blocks, and housing developments with repeated housing units. The quality of prefabricated housing units had increased to the point that they may not be distinguishable from traditionally-built units to those that live in them. The technique is also used in office blocks, warehouses and factory buildings. Prefabricated steel and glass sections are widely used for the exterior of large buildings [5].

Detached houses, cottages, log cabin, saunas, etc. are also sold with prefabricated elements. Prefabrication of modular wall elements allows building of complex thermal insulation, window frame components, etc. on an assembly line, which tends to improve quality over on-site construction of each individual wall or frame. Wood construction in particular benefits from the improved quality. However, tradition often favors building by hand in many countries, and the image of prefab as a "cheap" method only slows its adoption. However, current practice already allows the modifying the floor plan according to the customer's requirements and selecting the surfacing material, e.g. a personalized brick facade can be fabricated even if the load-supporting elements are timber [7].

Prefabrication saves engineering time on the construction site in civil engineering projects. This can be vital to the success of projects such as bridges and avalanche galleries, where weather conditions may only allow brief periods of construction. Prefabricated bridge elements and systems offer bridge designers and contractors significant advantages in terms of construction time, safety, environmental impact, constructibility, and cost. Prefabrication can also help minimize the impact on traffic from bridge building. Additionally, small, commonly-used structures such as concrete pylons are in most cases prefabricated.

Radio towers for mobile phone and other services often consist of multiple prefabricated sections. Modern lattice towers and guyed masts are also commonly assembled of prefabricated elements [1].

Prefabrication has become extensively used in the assembly of aircraft and spacecraft, with components such as wings and fuselage sections often being manufactured in different countries or states from the final assembly site. However this is sometimes for political rather than commercial reasons [6].

3. Issues and Barriers in the Execution of Prefab System in Malaysia

3.1 Issues

Even though the prefab system has been in existence for a long time but there are still many unresolved issues. One of the prefab system issues is the ability of the industry players to equip with necessary technical knowledge in order to adopt

prefab system in their project. Below are some more issues regarding prefab system implement in Malaysia.

One of the issues is prefab system as mass construction method. People often misinterpreted prefab system term by relate it with industrialized building that was built in 1960s. Pre-fabricated mass construction method, low quality billing leakages, abandoned projects, unpleasant architectural appearances and other drawback all this issues were normally associated with industrialized building. Public gave a bad impression about precast concrete because of poor architectural design [2,5,]. There several cases in Malaysia regarding the uses of prefab system had lead to such drawbacks. One of the cases is Pekeliling flats in Taman Tun Sardon, Gelugor, Penang. This flat was pre-fabricated flats, and it has been built for lower income group. To ensure the cost accommodation is low, this flat was constructed in mass. Design of this flats was very basic and not considering the aspect of serviceability. Due to lacking in design, the precast building going through some problem such as leakage and leakage has become the most common issue with precast building. Usually, low cost housings are not maintained properly, thus it gives a bad impressions and poor image of prefab system buildings [1,3,9].

Lack of involvement from small contractor are of the issues of execution prefab system in Malaysia. Many small contractors are reluctant to adapt prefab system and prefer to continue using the conventional method of construction. This is because they more familiar with the conventional system. They also believe that mechanized based systems are more suitable with small scale projects. Besides that, small contractors lack financial backup and are not able to set up their own manufacturing plants. Financial issues had become the main obstacle for small contractors to move forwards with the prefab system [2,9].

Lack of knowledge and exposures to prefab system technology discourages further implementation of prefab system. The subject of precast concrete design is normally not delivered to undergraduate students in many universities. Due to this problem, junior engineer does not know about precast concrete compare to the technology of structural steelwork. Knowledge in construction technology is equally important. Most common problems encounter are improper assembly of the components. Basically, there two vital aspects which is accurate levelling and alignment played their part for the successful of the rapid erection of precast concrete components. On the other hand, the lack of knowledge capability in designing the details of ties and connections of the prefabricated components are the technical issue frequently occur [3,4,7,9]

3.2 Barriers

Execution prefab system in Malaysia has not been making headways as anticipated even though the government has an early effort to promote usage of prefab system as an alternative traditional and labour-intensive construction

method. Some researchers have investigates and identifies a number of barriers to the effective implementation of prefab system in Malaysia. Based on the researcher information, basically the barriers to the prefab system in Malaysia can be summarized into five main area which is; cost and finance, skills and knowledge, project delivery and supply chain, perception of clients and professional and lastly the lack government incentives, directives and promotion. This barriers need to be solved if not it can affect the various stakeholders in the prefab system [6,10].

Cost and financial has been the biggest barriers in the execution of prefab system in the Malaysia. Past experiences shows that most of developer or contractor are afraid to use prefab method because it takes a lot of cost and most of them just want to stick to the traditional building method. This perception tends to discourages the usage of prefab system among the stakeholders, particularly, housing developers [1,5,7]. Prefab system philosophy is based on the mass production resulting in the reduction in the cost of production. However, most of the housing projects in Malaysia especially in northern part of Malaysia were constructed in small scales (less than 100 units). This situation tends to discourage the usage of prefab system because prefab system is based on the mass production. Moreover the recent statistics have shown that a general declined in demand and volatility of the building market for large public housing project. This has give a direct impact in usage of prefab system and have become the biggest barriers in the implementation of prefab system in Malaysia. Prefab system construction requires specialized equipment and machinery [1,9]

Research and Development (R&D) centre, supports services, and testing labs are also needed by an prefab system company in private sector. All of this required need a continual funding, only big company which are strong and stable financially could survives in the usage of prefab system. This will be a very hard situation for new local companies to enter the prefab system business since it needs extra capital investment. That is why conventional labour-intensive method become their choice rather than prefab system. This situation also closed the chance for a new company to compete for opportunities with international competitors that are stronger in terms of financial capability, technology or specialization [1,7,9]. Adopting a new system means that there need to be substantial and sustained budget, allocated time for training of human resources and specialized equipment and machineries. Lack of superior equipment and machineries proves to be a major hurdle that hinders works in prefab system -based projects [2]. Moreover, the lack of research and development (R&D) facilities has made the local contractors to depends very much on foreign expertise and technology. Other than that, all the material and machineries are imported from the developer countries and this will require a lot of cost to producing the prefab system component [8,10].

Besides the cost and financial barriers, poor of skill and lack of knowledge has become one of the barriers in the execution prefab system in Malaysia. Based on the previous studies have indicated that most local professionals and contractors

lack technical knowledge and experience in the prefab system [11]. Many local authorities are not fully conversant with modular co-ordinate and standardization concept associated with prefab system design and assembling procedures. Due to this problem, these local authorities tend to misinterpret prefab system current building guidelines adding to further delays in approval [11]. Prefab system demands more machine-oriented skills, both on sites and in factories. Due to this demand, restricting human resource in organization in terms of training in terms of training and education are requires. As we know, Malaysia still lacks skilled workers generally. By that, the intensive training programs are needed in the specialized prefab system skills. However, this need requires more time and investment [8].

Problems relating to manufacturer's requirement had been identified as one of the hurdles of prefab system adoption in the Malaysian construction industry [6,7]. In prefab system projects, to paid for the manufacturers, the contractors need to come out with an initial expenditures before any progress payment is made. However, our local contractor does not have the insufficient funds to pay the initial expenditures. Other than that, shortage or late supply of prefab system information, equipment and materials to sites has been an important barrier to the successful implementation of an prefab system project [3]. In Malaysia, all the majority prefab system manufactures or suppliers are located in industrial area like Klang Valley. This situation will prefab system directly increase the components of logistic and transportation costs in a construction project budget if it is located far away in rural areas [9] This situation will become worsened if a construction site is located too far away from the prefab system manufactures or suppliers. Weakness of prefab system lies in this cumbersome connections and jointing methods that open to errors and sloppy work [8]. For an example, poor jointing of prefabricated walls with other prefabricated or in-situ elements may give rise to water seepage problem prefab system high-rise building, especially during a heavy downpour in [1]. This problem become worse if not solve properly.

Prefab system always got a negative image due to past failure. Customer perception of an prefab system product is still perceived [2]. Not just the customers give a negative feedback towards the prefab system but professional too. In terms of architectural design, prefabricated elements are considered inflexible with respect to changes which may be required over its life span. Some designers are not interested in adopting prefab system due to lack of 'aesthetic value and limited creativity in design [4]

Poor respond on modular coordination and standardization concepts from the building industry is one of the reluctance to prefab system adoption. Modular coordination and standardization are among perquisite characteristics underlining the successful implementation of prefab system [8]. To overcome this problem, standard plans and standard component drawing are required. Prefab system implementation promotion and incentives of it widespread either by government or private agencies are still inadequate; hence the poor implementation of prefab system projects. Furthermore, prefab system products, manufacturers and

installers in the Malaysian construction industry do not have a dedicated assessment and certification systems. Lack of incentive training among existing construction professionals was also identified as being a potential hurdle to the widespread adoption of prefab system [1,3]. Some designers and consultants are reluctant to implement prefab system into their projects because of a few related issues, such as readiness constraint either in terms of knowledge, experience, skills or technology.

4. Critical Success Factor in Implementing Prefab System

Although Malaysian Government has promote prefab system systematically for several years starting from 2003 when the IBS Roadmap has been introduced, however the level of prefab system implementation is still consider as low compared to other country. There are many factors which affect the adoption of prefab system among practitioners which are demand and market factors, government initiatives and availability of expertise in prefab system [8]. Some of other factors have been identified by researches especially by CIDB. CIDB is a main researcher responsible to make sure Malaysian Construction Industry become more competitive [9].

4.1 Demand and Market Factor

Demand and market factor is one of the core factors which affecting the used of prefab system in Malaysian Construction Industry. If there are no demand from the customers (e.g. clients, developers, government or personal financial funded), there will be no project, neither conventional or prefab system.

For example, in United State, a study on prefabrication for conventional industry has started since early 1990 and until 1940; the respective parties were still struggling to developed prefabrication technologies. Only after the war period (1940-1945), the prefabrication being used extensively when government spent huge investment into very large settlement residential projects to overcome the problem of housing shortage. Then only the signs of prefabrication's growth showed up in United State [4].

Projects which used prefab system as a construction method in Malaysia mostly categorised as a mass project which involved thousands unit of houses for residential projects or more than 10 stories high-rise building. If not, the project must be government funded project such as schools project, government quarters or commercial buildings with special purposes.

In 2005, CIDB had done a survey on the architect and shows that 67% of prefab system project is government funded projects [12]. e to this fact, Malaysian government have made a final decision on October 2008 through a new circulation stated that the use of prefab system for government project is compulsory effective on the circulation date. Even the project being awarded before the date,

it would still compulsory to use prefab system. This measure is purposely done to increase the demand of prefab system in construction industry.

4.2 Government Initiatives

A government initiative in adoption of prefab system among contractors is a really important as a step to promote, guide, facilitate and reduce the burden on the contractors. Malaysian government through its agencies (CIDB and JKR) has done a lot of things to ensure successful prefab system implementation as targeted in IBS Roadmap [3]. Modular design guide, IBS Score manual, Manual IBS implementation for government project and construction Industry Standard (CIS) as a guideline for the construction industry's practitioners. To promote prefab system, CIDB had published freely all about prefab system through its website.

Moreover, to provide a platform for all construction industry players and prefab system practitioners to built network, share ideas and discover the latest of prefab system technology, Malaysian International IBS Exhibition has been organized two times by CIDB in 2006 and 2009 respectively with Pusat Khidmat Kontarktor (PKK) and Ministry of Entrepreneur and Co-operative Development.

Not enough with organising international exhibition, CIDB has also organised road show on prefab system as a vendor development programme to tighten supply chain in prefab system industry. Even though a lot of facilities have been provided such as IBS one stop centre, IBS Orange Books, improve the policies through UBBL and Malaysian Standard (MS1064 Part 1-10) and development of IBS village at Cheras, however, there is still various loops need to be covered to achieve a successful prefab system implementation [6].

4.3 Availability of Prefab System Expertise

Low amount of expertise in Malaysia in prefab system method is another reason why prefab system is not being used extensively until now. The current civil engineering and architecture curriculum rarely state prefab system as one of compulsory subjects to be taken by student while taking their degree at university. As a result, there are not enough professionals that can be claimed as experts in precast concrete systems. Therefore, this may lead to poor design, plant management and production and erection practices [2].

According to manufacturer perspective, lack of competence can cause failures in the production stage that in turn may cause delays in the erection schedule. These affect not only to the manufacturer but also to the contractor, because it avoid contractor from gaining profit through short construction period. Beside that, lack of expertise on behalf of the contractor can cause delays in the erection schedule, even if the components are delivered to site on time [7]

Finally, the designers with expertise in precast concrete system have no choice and inevitable to used conventional method to avoid the use of these system. In terms of structural analysis and design of precast concrete components, there is

not much different with conventional reinforced concrete structure, but an important issue when applying prefab system is joint analysis and design. Thus, conflicts of responsibility often arise between manufacturers and designers at that state [3,9]]

4.4 Prefab System In Practitioners Perspective

In construction industry there are four players consist of contractor, consultant, client and manufacturer. Each of them involved with prefab system usage in different ways but sometimes within the same scope of works. For example between manufacturer and designer, both of them involved with design works but in different phase of works [5]. This may lead on conflict among them.

4.5 Manufacturer Perspective

In prefab system, contribution of manufacturer is not only limited to manufacture the product but also involved in planning, design, and project management and implementation process. Looking the experience of Setia Precast Sdn Bhd as an established precast concrete manufacturer, first thing to do is converting the conventional design into more comprehensive design needed for precast construction. After that, the production work will take place and followed by transporting, erecting and joining the elements. In this context, even though they are manufacturer, the scale of work being covered is broad compared to manufacturer for conventional system who's only responsible to supply materials for contractor [10,11].

4.6 Client Perspective

Client is the most important party in improving the used of prefab system in construction industry. Unfortunately, there are lists of barriers which overcome client enthusiasm to used prefab system. According to Orange Book, ten out of fifteen precast manufacturers located around Selangor and Kuala Lumpur and only five distributed in other states in Malaysia [1]. The problem become more critical because only several of them produce complete set of prefab components. That's why client need to reconsider their decision to use prefab system for their projects. Development of prefab system limited due to Malaysian 'island mentality' and lack of collaborative approach. In developing industry, project leadership and site management issues like lack of standard and certification as a guideline for products, process and short of specialist crew have amplified the barriers [6].

4.7 Consultant Perspective

Current technical solutions including Modular Coordination, Malaysian Standard and Precast catalogue are not sufficient to suit traditional procurement process and it will affect the preference of designer on traditional method. Most of civil and

structure consultant (C&S) will be appointed by contractor who have win Design and Built tender on prefab system project. Based on architectural drawing, structural drawing will be produces traditionally but stress more on joining element [8,9]. Generally, suggestion of joining element and component will be suggested by manufacturer and C&S consultant will just follow the suggestion. This is sometimes may lead to redesign work which means increased in design cost [5].

4.8 Contractor Perspective

Most of the contractor in Malaysia already have permanent relationship in supply chain, sub contractors and clients who are the main contributors for their projects and they are already comfort with their working environment which indeed explained why they reluctant in changing the method of construction from conventional to prefab system [10]. Even though they are willing to change, a lot of incentives for training purposes are needed which means higher cost to start implementing prefab system.

4.9 CIDB Responsibilites

IBS Centre becomes one one-stop reference centre to ensure the successful of IBS Roadmap 2003-2010 [13] and Roadmap 2011-2015 [14] regarding prefab system for both government and private sectors. IBS Centre becomes place for promote knowledge, sharing information and facilitate better cooperation regarding prefab system among the stakeholders. Several key programs have been planned and implemented based on a development framework that is divided into two components.

The first component is the Capability Building that is based on Soft Aspects (Knowledge Development). While Soft Aspects are being emphasises, the importance of the Hard Aspects are also being acknowledge. The second important is the Capacity Building which is based on Hard Aspects (Technology & Physical Projects Development).

Activities in IBS Centre are being executes based on the five main thrusts of the IBS Centre comprise of: (1) prefab system Industry Planning; (2) prefab system Promotion and Marketing; (3) prefab system Technology; (4) prefab system Certification and Verification; and (5) prefab system Training. One of the main functions of IBS Centre is to act the main secretariat of IBS Roadmap and industry coordination.

The implementation of prefab system in Malaysia is being monitored by the Construction Industry Master Plan (CIMP) Committee as well as the IBS Steering Committee. Both committees are represented by relevant government agencies as well as industry leaders. IBS Centre also supports partnering (joint venture) developments and functions as a gateway to market prefab products domestically and internationally. In supporting the National Mission, Bumipetera development programs are also being emphasised. For information and marketing purposes, the

programs being organised are related to seminars, road shows, promotional activities and knowledge sharing sessions.

Other than activities involving with the industry players, it also involves development of IBS Centre as a proactive role in supporting the human capital development needs and also IBS Showcase. The IBS Showcase is equally important as it offers Malaysia's largest external display of prefab components' application. While industry planning and knowledge development is being given main priority, the hard aspects of prefab systems are also being addressed by IBS Centre. CIDB Malaysia, through CREAM, supports research and development as well as technology transfer programs by local experts. Since 2007, a total of RM19.13 million has been provided for the prefab system researchers.

The development of prefab system related Malaysian Standard (MS) and Construction Industry Standard (CIS) as well as design systemisation exercises are also being supported by the IBS Centre. It also offers a special incubator program for local prefab system technical entrepreneurs as well as general technical prefab system advisory services to the industry.

IBS Centre also handles the evaluation, certification and registration of prefab system players in Malaysia. Currently, the prefab system Status program is offered to prefab system manufacturers, consultants and contractors. This initiative is essential in avoiding inferior service providers and manufacturers from affecting the initiative. The prefab system Status program is not restricted to verification exercises only as it can also be used to support incentives programs. Until 2009, a total of 119 prefab system manufacturers are registered with IBS Centre, out of that, 26 companies are verified and included in the prefab system Manufacturers Status List. As for consultants, there are 16 Quantity Surveyors, 26 Architects and 52 Engineers company have been listed in the prefab system Consultant List 2008.
Human capital development programs through trainings are also a strong focus area for the IBS Centre. IBS Centre is playing a proactive role in supporting the human capital development needs through continuous and well-structure programs. There are always monthly training programs provided by CIDB for construction practitioners who are interested in starting prefab system business. More than that, there are also training program provided for fresh graduate who are interested to learn more on prefab system including planning and management, technical matters and design skills

5. Conclusion

This paper had presented the potential of green prefab construction in Malaysia. Prefab construction technique is very cost-saving holistically and often makes it possible to finish a building project in as much as half the time required compared to traditional methods of construction. Prefab construction is frequently employed with the construction of new houses; the strategy can also be used with other buildings. The outstanding ability behind prefab construction is based on the

idea that by using standard components that are partly assembled on a manufacturing floor, there is less time involved in the actual construction process. The modules are transported to the site, using freight transportation. At the site, the modules are unloaded, moved into position with the aid of heavy machinery, and connected to form a single building. Along with the fast assembly, prefab construction could often save a great deal of money on the building construction. It seems that examples of successful implementations of such an established manufacturing process have not been fully appreciated by the local construction industry. Maybe a greater intervention from government linked companies are needed to set up the mega housing projects and to provide an endless supply of ready-made components for buildings by multiple vendors and suppliers

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