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AFFORDABLE HOUSING SOLUTION THROUGH THE ADOPTION OF IBS AND MMC IN THE MALAYSIAN CONSTRUCTION INDUSTRY

Mohammad Fadhil Mohammad[1], Muhamad Faiz Musa[1], Ani Saifuza Abdul Shukor[1], Rofizlan Ahmad[2] and Idrus Din[2]

[1]Construction Economics and Procurement Research Group, Centre of Studies for Quantity Surveying, Faculty of Architecture, Planning & Surveying, Universiti Teknologi MARA, Selangor, Malaysia.

[2]IBS Centre, Construction Industry Development Board, Malaysia

Corresponding author: fadhilnavy@yahoo.com

Abstract

Affordable housing has always been a global issue whereby the demand from the very low, low, and moderate-income households cannot be met especially by governments from developing countries. Affordable housing is also a major problem in Malaysia whereby it is constantly associated with the issues of cost, quality, and productivity. The main research focuses on the efforts of the Malaysian construction industry players in working around innovative Industrialised Building System (IBS) and Modern Method of Construction (MMC) to address successfully the core issues and challenges related to the Malaysian affordable housing. Case studies are being carried out to investigate the new IBS, and MMC developed amongst the five selected organisations in the Malaysian construction industry. The significance of the study is to highlight to respective public and private stakeholders on how innovative construction methods such as IBS and MMC can successfully deliver and contribute to affordable housing solution in Malaysia.

Keywords: *Affordable housing, Industrialised Building System, Modern Method of Construction, Productivity, and Quality*

Introduction

Affordable housing is defined as a housing that is appropriate and affordable for the needs for very low to moderate-income households. Affordable housing needs to meet the basics of households whose incomes are not adequate to allow them to access appropriate housing in the property market without assistance. The definition of affordable housing in other countries might be different and vary (Gopalan & Venkataraman, 2015). Over the last decade, the housing market has experienced an escalation of house prices, mainly in major cities and caused inaccessibility to housing. Therefore, the issue of affordable housing is taking center stage internationally due to the increase of housing price globally.

Housing forms one of the essentials of a human. Maslow's Theory Hierarchy of Needs tells that housing forms the vital primary needs for a human, in addition to job, security, food and others, at the lowest among the five levels (Aziz et al., 2010). Housing contributes significantly to the socio-economic development and the wellbeing of communities. It serves

as a shelter and provides a vibrant living environment that will influence and shape human behavior, productivity, and development.

Affordable housing is essential because it is to ensure that everyone can own a house despite the increase in housing price, especially for the very low to medium income households. Affordable housing creates diversity through promoting a variety of demographics and creates communities with a rich combination of culture, socio-economic circumstance, age, and education. Furthermore, affordable housing can create jobs and stimulate the local economic development. According to Wardrip et al. (2011), affordable housing development increases the spending and employment in the surrounding economy, that acts as a source of revenue for local governments, and reduces the likelihood of foreclosure. Affordable housing development can decrease the commute times and transportation costs especially in the city where the affordable housing will be strata and transportation/transit oriented development.

Affordable housing is also a major problem in Malaysia whereby it is constantly associated with the issues of lack of supply, high cost, low quality, and low productivity. The Malaysian government acknowledged the importance of affordable housing. Thus, the Malaysian government has drawn various policies to facilitate house ownership. Initiatives are also being made by the Malaysian housing and construction industry players to address the issues and challenges related to the Malaysian affordable housing. Innovative and new construction methods that include IBS and MMC are being explored by the construction industry players as a solution to the affordable housing issue.

Affordable Housing in Malaysia

The lack of an adequate number of affordable housing in Malaysia has been a serious problem for a very long time. The population of Malaysia has amplified from 21.3 million in 2000 to 30 million people in 2013 with a growth rate of 1.6%. The death and birth rate have reduced over the years with an increase in the life expectancy from 71 years to higher than 73 years. The gross domestic product (GDP) has also increased along with the per capita income. The housing and property prices have also increased by a record margin. In the last five years, the prices have increased by 12.3% annually in Malaysia.

Currently, there is a 40% difference between the demand for affordable housing and its supply in Malaysia at the moment. According to the Department of Statistics Malaysia Housing Income Survey 2013 (2013) stated that 80% Malaysians earn less than RM 6,900 per month and cannot afford houses priced at higher than RM 300,000.

According to the report of National Property Information Centre 2014, only 31.7% of the total number of housing units built in the year 2012 had a price tag below RM 250,000 (NAPIC, 2014). The escalating income of the middle class is finding it tough to keep pace with the price hike of housing units that leads to the need for affordable housing becomes more important than ever before.

Besides the lack of supply of affordable housing, affordable housing in Malaysia faces other problems that include high housing development cost, low quality and lack of involvement from the private sector. Moreover, the affordable housing is unsatisfactory to the family occupying in term of family housing needs, comfort, social, cultural and religion needs (Rahman et al., 2013). Efforts are being made by the Malaysian government to solve the affordable housing problems and challenges. Various policies are drawn by the Malaysian government to resolve the affordable housing issues that include the National Physical Plan, National Housing Plan, RUMAWIP policy and the Five Years Malaysia Plan including giving new and additional allocation in the National Budget every year.

The Malaysian government will continue to act as a major role in ensuring the value of affordable housing by continuing the existing programmes, providing financing facilities, expanding rental and Rent-to-Own housing programmes. Furthermore, the enrichment of the role of the private sectors in the Malaysian housing industry looks like a strategic role in creating an enabling environment to encourage the private sector participation in the development of affordable housing in Malaysia.

Housing Development Cost

The most critical issue concerning the successful implementation of affordable housing is the cost of development. For housing development cost in Malaysia, the following are the four main components that include (MOHSS, 2015):

a. Land cost;
b. Construction cost (building cost + infrastructure cost);
c. Consultant's professional fees;
d. Fees or contribution to government agencies.

Ghani Salleh and Meng (1997) has highlighted that the construction cost has been the major cost for housing development in Malaysia since the late 90's. Construction cost comprises building cost and infrastructure cost. The study will be focusing on the housing building cost since the innovative construction method developed by the Malaysian construction industry players only affects the building cost. Furthermore, building cost contribute a larger or higher percentage of the overall construction cost compared to the infrastructure cost for a housing development (MOHSS, 2015). To date, the minimum building cost in Malaysia is 90.00 Ringgit Malaysia (RM) or 22.17 United State Dollar (USD) per square feet (per sqft) which adopt conventional or traditional construction method.

The conventional construction method is slow, unproductive, low quality in the end products, lack of safety and non-environmental friendly (Musa et al., 2014). Thus, it is essential for the Malaysian construction and housing industry to adopt innovative and new construction methods. Innovative and modern construction method is productive, deliver high-quality end products, cost effective and promotes sustainability in the construction environment (Mohammad, 2013; Musa et al., 2015). Despite the benefits of adopting new technology in the construction and housing sector, the investors or organisations need to abide the initial and capital cost of the new technology that might lead to an increase of cost in the construction and housing sector.

The Introduction of IBS and Modern Method of Construction (MMC) in Malaysia

The introduction of new modern method of construction and industrialising the construction sector in Malaysia began in the early 1960's. The Malaysian government initiated pilot projects that adopt new construction methods aiming to speed up the delivery time of the project. (Muhamad Faiz Musa et al., 2015) The Malaysian widely uses the term IBS, to represent industrialisation and new construction method in the Malaysian construction industry. To date, there are many industrialisations, off-site manufacturing and modern method of construction terminologies in the construction industry, but IBS had become a term to represent those terminologies in the Malaysian construction industry. Even though the introduction of IBS in Malaysia is over 40 years ago, its acceptance was not extensive, and the IBS application is still slow. Despite the potential of IBS, the adoption and uptake on IBS in the Malaysian construction industry are low (Musa et al., 2015).

To promote IBS in the Malaysian construction sector, the Malaysian government and Construction Industry Development Board (CIDB) introduced plans and strategies to encourage the implementation of IBS. The policies include the introduction of Malaysian Construction Industry Master Plan 2006-2015 (CIMP 2006-2015) and IBS Roadmap (Muhamad Faiz Musa et al., 2015). The latest policy to enhance the adoption IBS is through the Malaysian Construction Industry Transformation Programme 2016-2020 (CITP 2016-2020).

CITP (2015) has highlighted the need to improve the productivity of the Malaysian construction industry. The enhancement of productivity in the Malaysian construction industry will be possible through the improvement of human capital development, adoption of technology and mechanisation and modernization of the construction process that would be possible through IBS. The advantages to IBS are that it reduces the impact of project orientation and establishes a factory with a high degree of stability in production and coordination with subcontractors, suppliers, and designers. Currently, reliable and fast delivery times are regarded as the most important characteristics of IBS. Competitors implementing conventional construction, onsite, and project-oriented building are unable to offer these tight time frames that yield fast returns on investments for clients (Mohammad, 2013; Muhamad Faiz Musa et al., 2015). Therefore, through CITP it is hoped that the usage of IBS will be widespread and increased in the Malaysian construction sector. In the current Malaysian context, CIDB has classified the IBS into six types that are: (CIDB, 2003).

a. IBS Pre-cast concrete system
b. IBS Formwork system
c. IBS Steel framing system
d. IBS Prefabricated timber framing system
e. IBS Block works system
f. IBS Innovative system

Research Methodology

The aim of the study is to investigate the efforts of the Malaysian construction industry players in working around with IBS and MMC to address successfully the core issues and challenges related to the Malaysian affordable housing. Thus, qualitative approaches using case study was used to achieve the aim of the study. Case studies are being carried out to investigate the new IBS, and MMC adopted in the five selected organisations in the Malaysian construction industry. The case studies are houses that had been built using IBS and MMC. Data for the case studies is collected through the meeting, presentation by the organisations that developed the IBS or MMC, sites visit, and factories visit. The collected data from the case studies include images, costing, features; benefits and type of IBS and MMC used. The data is then analysed using comparative analysis and displayed using a table.

Case Studies

There are five case studies for the research. Each case study represents a house built using an IBS product or MMC by the organisation that developed the IBS product or MMC. All the houses in the case studies have complied with the minimum requirements outlined in the Malaysian Uniform Building by-Laws 1984 (UBBL 1984). Malaysian UBBL 1984 is a set of guideline for building design, requirements, and laws that need to be fulfilled by the designer or architect in designing a building (UBBL, 1984). The requirements outlined in UBBL 1984 include access, lighting, health, safety, space, ventilation, building's height, and fire protection for the building. To achieve the balance between good design, great functionality, and the law, the architect will need to comprehend the UBBL 1984. Amendments to UBBL 1984 are being made throughout the years to ensure the validity of UBBL 1984 due to the innovation and new technology introduced in the building and construction industry.

Building's drawing or plan submitted to the Local Authority needs to comply with UBBL to avoid amendments to the drawing or being rejected by the Local Authority. The Local Authority is responsible for assessing and inspecting the submitted building's drawing and plan. Building's plan comply with UBBL 1984 can proceed to the construction stage. Local Authority is set up by Malaysian State Government, in consultation with the Ministry of Housing & Local Government and the Election Commission.

Case Study A

Figure 1: Modular Prefabricated House

Case Study A as shown in **Figures 1 & 2** is a modular prefabricated house produced using the modular prefabricated building system or modular construction. Modular prefabricated building system and modular construction are new in Malaysia. To date, there are only two modular prefabricated building system manufacturers in Malaysia. Modular prefabricated building system or modular construction is classified as off-site prefabrication and modern method of construction and used in developed countries such as US, UK, Japan, European countries and Australia. Modular house produced is high quality, speed up project schedule, promotes sustainability, flexible and ease renovation (Musa et al., 2014). The floor area of the house for case study A is 800 sqft. The structure of the modular prefabricated house is made from lightweight galvanised steel. The façade of the house is made from custom made façade that has insulation capability produced by the manufacturer. The building cost of the modular prefabricated house includes the foundation cost RM 75,000. The total construction period of the modular prefabricated house includes the manufacturing process of the modular units and site installation is about two weeks.

Figure 2: Modular Prefabricated Building System or Modular Construction

Case Study B

Figure 3: Shipping Container House

Case Study B as in **Figure 3** is basically a shipping container house. Building constructed using shipping containers is globally well-known. The use of shipping containers as a building material has grown in popularity in the past several years due to their strength, wide availability, and relatively cheap. Nowadays, house built using shipping containers are seen as more eco-friendly than conventional building materials such as brick and cement. The container house for ***Case Study B*** comprises two units of 40’ x 8’ x $8^{1/2}$’ shipping containers. The floor area of the

container house is 700 sqft. The manufacturer for ***Case Study B*** has developed the Modularcraft system comprises the use of recycled or used shipping containers as the basic building module combined with the Primer-X. Primer-X is a thermal insulation coating applied to the external surface of the shipping containers. The important use of the Primer-X on the shipping containers demonstrates the habitability for human to live inside of shipping containers despite our equatorial climate. The building cost of the shipping container house is RM 68,000. The total construction period of the shipping container house includes the refurbishment process of the shipping containers and site installation is about three to four weeks.

Case Study C

Figure 4: House built using On-Site Monolithic Building System

Case Study C is a house built using on-site monolithic building system as illustrated in **Figure 4**. The monolithic building system is widely recognised as one of the most practical, economically and technically feasible solutions to the problem of building cost-effective, durable and earthquake-proof housing on a mass scale, quickly and efficiently. Monolithic building system or construction requires formworks to shape the concrete into the different structural shapes needed to carry the building loads (**Figure 5**). The form works to create the voids where steel reinforcing rods are placed followed by filling it with self-levelling concrete in its liquid state, which is poured creating the structural components such as columns, walls, beams and roof slabs.

Figure 5: Formwork Installation On-Site

The house built for ***Case Study C*** is the fastest cast-in-situ reinforced concrete structure construction method in Malaysia, introduced as FASTBUILD Monolithic Building System. The floor area of the monolithic house is 890 sqft. Firstly, the aluminium formwork system is designed according to the building drawings. A custom made self–levelling concrete is then

poured into the formwork once it has been installed, and it is placed at the worksite. When the entire first floor is completed, the formwork panels are easily removed and manually transferred to the subsequent floors where the process is repeated until the whole building is constructed. Repetition is the key to cost efficiency. The structure cost is RM 33,000. The building cost of the monolithic house for mass production is RM 66, 000. The minimum units of 25 units to be constructed to achieve the cost saving, repetition usage of the formworks and standardise building plan. The total construction period of the monolithic house using the system developed by the manufacturer is about one to two weeks.

Case Study D

Figure 6: House Built Using IBS Steel Framing System

Case Study D is a house that used IBS steel framing system that adopts the Malaysian housing features. The system as shown in **Figures 6 & 7** is called the Enduro frame Building System. The technology used for the system is from Australia. The steel framing system can be used in building, adding a floor, re-roofing or adding light partitions and external claddings. A house of 800 sqft using the Enduro frame Building System only took seven days to be completed. It only required eight workers. Light weight steel framing combined with its design versatility and flexibility, means a steel-framed house can be built with minimal site impact. The combination of the wet wall system using concrete is essential. The concrete is poured on-site using pump once the light weight steel framings are erected. The building cost for a house of 800 sqft built using the Enduro frame Building System is RM 64,000. The limitation of the system is it only cater single storey landed house.

Figure 7: The Erection of the Lightweight Steel Framings into a House

Case Study E

Figure 8: House constructed using IBS Innovative System (EPS)

Figures 8 & 9 shows the house for ***Case Study E*** which is constructed using 100% recyclable raw material of EPS (Expanded Polystyrene) panels that has a lightweight characteristic. The panels are classified under IBS innovative system. The EPS panel consists of a double layered high tensile wire mesh stitched together with an inner layer of EPS. When sprayed with concrete on both sides, it will form a solid composite structure that has the rigidity and strength superior to the conventional brick wall. A temporary support is used to support the panels before the panels are sprayed with concrete. The house for ***Case Study E*** is 1000 sqft and the building cost is RM 80,000. The construction period for the house in case study E is three to four weeks.

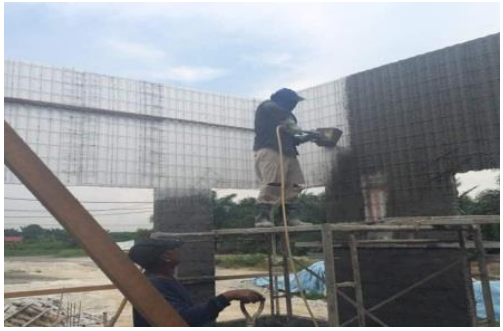

Figure 9: Concrete Spraying Process on the EPS Panels

The cost of constructing a house is a critical issue in Malaysia. High building cost makes it difficult to provide affordable housing. **Table 1** will be comparing the building cost of every house built using IBS and MMC as described in the case studies. The building cost of the conventional construction method per one sqft is set as the cost benchmark of the study. The benefits, type of IBS/ MMC and features of every case studies and conventional construction method is also included in Table 1.

	Conventional Construction Method	***Case Study A***	***Case Study B***	***Case Study C***	***Case Study D***	***Case Study E***
Image						
House features	-	-800 sqft -3 bedrooms & 2 toilets	-700 sqft -3 bedrooms & 2 toilets	-890 sqft -3 bedrooms & 2 toilets	-800 sqft -3 bedrooms & 2 toilets	-1000 sqft -3 bedrooms & 2 toilets
Building cost	-	RM 75,000	RM 68,000	RM 66,000	RM 64,000	RM 80,000
Building cost per one sqft	RM 90.00 (The current building cost per one sqft for conventional construction method in Malaysia)	RM 93.75 (RM 75000/ 800sq ft)	RM 97.14 (RM 68000/ 700sq ft)	RM 74.15 (RM 66000/ 890sq ft)	RM 80.00 (RM 64000/ 800sq ft)	RM 80.00 (RM 80000/ 1000sq ft)
Type of IBS/ MMC used	-	Modular prefabricated building system	Shipping container construction	On-site monolith building system	IBS steel framing system	IBS innovative system
Benefits using the IBS/ MMC	-Cheap	-Fast -High-quality construction workmanship of the end product	-Fast -High-quality construction workmanship of the end product	-Cost efficient -Fast -High-quality construction workmanship of the end product	-Cost efficient -Fast -High-quality construction workmanship of the end product	-Cost efficient -Fast -High-quality construction workmanship of the end product

Table 1: The Comparison between Conventional Construction Method and the Case Studies

Findings and Conclusion

From the data gathered and comparison displayed in Table 1, IBS and MMC can successfully deliver and contribute to affordable housing solution in Malaysia. Case study C, D, and E had proven that the IBS and MMC are cheaper and cost efficient compared to conventional construction method. Case studies C, D, and E building cost per sqft is cheaper compared to the conventional construction method per sqft that is below RM 90.00. Furthermore, IBS and MMC used are faster, productive, and produce high-quality end products especially in term of construction workmanship. Due to excessive dependent on unskilled foreign labours, the Malaysian construction, housing and building industry faced low-quality construction workmanship in the industries' end products. Case study A and B is slightly expensive compared to the conventional construction method.

The research has shown that IBS and MMC have all the potentials in addressing and meeting the solutions to the Malaysian affordable housing issues in term of cost, quality in term of construction workmanship of the end products, and productivity in the construction sector. It is hoped that this research will be able to change the perception and encourage the private and public stakeholders towards IBS and MMC adoption in constructing affordable housing in Malaysia.

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