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# Literature Mapping: Critical Factors in Industrialized Building System Plastic Formwork Application

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### ABSTRACT

Industrialized building system (IBS) in Malaysia has been practiced for decades. The development of its formal practice parallels with the improvement of the built environment in the nation. One of the applications is on formwork. IBS plastic formwork has been promoted by Construction Industry Development Board Malaysia as an alternative to replace the conventional formwork system but the involvement from the public and private sectors in applying the IBS plastic formwork is seen reluctant. The aim of this study is to review the gaps that exist especially on awareness and readiness in application of IBS plastic formwork. Very relying on literature, this paper discovered a gap that is considered as critical factors in the successful of IBS plastic formwork application in construction industry. This paper aims to give new bits of knowledge in IBS formwork to upgrade the application of IBS plastic formwork as well as an alternative solution to enhancing the used of IBS in Malaysia.

**Keywords:** Industrialized Building System, Industrialized Building System Plastic Formwork, Critical Factors, Industrialized Building System Application

**JEL Classifications:** M1, L74

## 1. INTRODUCTION

Formwork plays important roles in producing concrete structure which allows contractors to cast the main parts of a building which are required as a strong support to the structure and building (Hanafi et al., 2015). Construction Industry Development Board (CIDB) has been promoted Industrialized Building System (IBS) plastic formwork as an alternative to replace the conventional system when realized that this components is full of benefits and one of the important element in construction (Ghazali, 2014). By referring to Hanna, 1999 found in Ghazali (2014), formwork is a temporary structure that was provided to containment especially for the fresh concrete.

It was designed from a material that can support loads of the equipment, workers, impact of various kinds, or sometimes wind without collapse or excessive deflection. IBS plastic formwork was introduced and its offered a lot of benefit in terms of sustainable element of formwork such as lightweight, speed of construction, lower life-cycle costs and indestructible with strong formwork panels that are interlocking and modular in nature, make it easily to construct the formwork for concrete. These forms have become increasingly popular for casting unique shapes and patterns being designed in concrete because of the excellent finish obtained requiring minimum or no surface treatment and repairs. IBS plastic formwork offered with various types of plastic forms like glass reinforced plastic, fiber reinforced plastic and thermoplastics (Haron et al., 2005).

## 2. PROBLEMS AND ISSUES

The application of IBS plastic formwork in Malaysia is still reluctant comparing to the other developing country such as United States, United Kingdom and Australia (Zawawi, 2009). Well said by Ghazali (2014), this issue has been trigger due to the awareness and readiness of contractors although the majority of stakeholders has given a full commitment and aggressively promoted the IBS components.

By referring to CIDB, 2006, the procedure of IBS system, required high initial investment capital for pre-casters or manufacturer to purchase new machinery, mould, knowledge and technology transfer and highly paid of skilled workers and Kamar et al. (2010) stress out, small contractors are familiar with the conventional systems and for them the technology was suit well with small scale projects and therefore they are not willing to switch to mechanized based system with uncompetitive industry due to lack of open collaboration which is the contractors in Malaysia are obligate to close system and getting supply from the same manufacture throughout the construction (Chung and Kadir, 2007).

Moreover, competitive prices Ghazali (2014), between conventional and IBS formwork and the awareness in application and demand of IBS between stakeholders are intentionally contributed to the application of IBS in Malaysia (CIDB, 2003).

## 3. CRITICAL FACTORS IN IBS PLASTIC FORMWORK APPLICATION

A critical factor is defined as the factors which contributed to the ineffective result and achievement towards successful of building construction with considering of time, quality and cost. IBS formwork is being acknowledged in many writings as contribute to the issues on application in construction including plastic formwork.

According to Ghazali (2014), IBS Survey 2010 highlighted that the use of formworks system (metal, aluminium and plastic) gained its popularity recently due to its flexibility which can be used in many projects, recyclable at many phase of construction and can be used in different types of design structure. However, the level of IBS usage especially in plastic formwork is still considered as low in Malaysian Construction Industry (Mohamad et al., 2009). Several factors and difficulties give an effect to the IBS formwork implementations were identified as difficulties.

### 3.1. Lack of Awareness on Training and Short Courses for Contractors

Based on Mohamad et al. (2009), in the Malaysian Journal of Civil Engineering, the frequency of analysis results showed that only 56% of the respondents aware that IBS training and short course was provided for contractor which could help and guide them in implementation of IBS component including IBS plastic formwork. According to Rahman and Omar (2006); contractors and even engineers are not well aware of the IBS system and not involved with the use of any IBS system in their construction

methods due to lack of involvement in training and short courses regarding IBS course. It was agreed by Yahya and Shafie (2012) that stated most of the barriers in implementing IBS are lack of manpower skills due to unattended of training and short course organized by responsible party which is CIDB. As to overcome the problem, Majid et al. (2011) in their research suggest that the government should obligate most of the IBS stakeholders to attend in IBS training. In fact, they added the responsibility to educate and build up the awareness should be carried out by government as well as policy maker as to increase the implementation of IBS product.

### 3.2. Lack of Awareness on Product Marketability

There are various types of IBS references in market today. Nevertheless, the awareness of these various IBS references in market including the IBS plastic formwork is unsatisfied. According to results in Malaysian Journal of Civil Engineering (2009), the study found that, despite the respondents' awareness on IBS existence is over than half percentage, but they are quite unaware on the availability of various IBS references. Based on the previous research carried by (Mohamad et al., 2009), it only shows that only 50% from the respondent is aware to the various types of IBS references in market. According to Rahman and Omar (2006) and Majid et al. (2011) claimed that, in order to create awareness among practicing engineers and contractors, campaign and marketing strategy which to reassure that IBS systems are able to provide fast, economical and high quality products should be carried out. The awareness campaigns may include seminars and short courses with collaboration among universities, manufacturers, professional bodies and responsible party such as CIDB will facilitate the spread of knowledge for contractors and engineers about the IBS system. Meanwhile, in a way of promoting IBS components, scientific information should become a main agenda since most of the project goes for sustainable construction nowadays (Yahya and Shafie, 2012).

### 3.3. Lack of Readiness in Financial Capabilities

The financial factor is the most critical factor to be considered in the readiness of using the IBS component consisting of IBS plastic formwork (Mohamad et al., 2009). They added, it was impossible to the contractor winning the tender using IBS price while the other companies were bidding to use conventional price for regular construction method. On the other hand, based on the previous research done by Mohamad et al. (2009), actually 70% of the contractors were financially ready in using the IBS component consisting IBS plastic formwork. The other 30% is unready to used IBS component according to their company financially capable. Meanwhile, regarding to Rahman and Omar (2006), the high initial cost in purchasing a mould as well as the cost of transportation has reduce the margin profit which consequently affect on financial capabilities. They added, in certain circumstances, switching to IBS components would not guarantee significant savings in the cost especially with the small volume of buildings constructed. Based on the study conducted by Majid et al. (2011) revealed that IBS implementation is still incurred a higher cost compared to the conventional method. In that case, some of scholars' agreed that the government should prepare an alternative as to support to companies which experienced

from financial capabilities especially for small scale contractor. Furthermore, Yahya and Shafie (2012) also claimed that due to lack of incentive and promotion from government in the use of IBS, many architects and engineers are still unaware of the basic of IBS such as modular coordination.

### 3.4. High Initial Investment Capital

According to Chung and Kadir (2007), the most significant difficulties which restricting the use of IBS among the contractors was considered as higher construction cost and high capital investment. According to Kamar et al. (2010), in his research highlights the initial investment capital which considered as an initial cost is involved the money that will invest before the project begin. He added, in using an IBS component, the contractor must have a complete machinery to facilitate the IBS components installation. In fact, this machinery will bring a significant impact due to initial investment capital when the contractors shift from the conventional method to IBS system. Besides that, based on study by Mohamad et al. (2009), the IBS installation method is considered as a foreign technology based on the differentiation of installation compared to the conventional methods. This also involved the increasing of initial investment capital to the contractor when they try to importing this foreign technology in their construction project. Meanwhile, the other critical factors of which are required in mould installation of IBS plastic formworks is experience and knowledge of the IBS component. The installation of the component must be done by the expertise or skilled worker which familiar with the IBS component. Hence, it will force the contractor to use the skilled worker as their labor which brings a significant impact on the total cost.

### 3.5. Familiarity of Conventional Method

Based on Chung and Kadir (2007) revealed that small contractors are already familiar with the conventional system since the technology suit well with small scale projects and therefore not willing to switch to mechanized based system. It was agreed by Kamar et al. (2010) which proved that the IBS plastic formwork and the other component are not familiar to the small contractor. Recently, the small scale project which done by small contractor will used a conventional method which are believed more appropriate and recognizable among the contractor. Nevertheless, the used of IBS plastic formwork or the other component in IBS is giving more advantages according to their time saving in completing the project. Despite it still have lack in their implementation, the choice is depends on the contractor on how to choose the best construction method which bring a good impact to the project.

### 3.6. Uncompetitive Industry

Uncompetitive industry situation in Malaysia was happened in long time period and involved a numerous stakeholders who are from contractor, consultant, supplier and even the costumer. According Chung and Kadir (2007), the uncompetitive industry is happen due to lack of open collaboration which are the contractors in Malaysia is obligate to use a close system and getting supply from the same manufacture throughout the construction. The government of Malaysia has agreed to expand the method of IBS in construction sector and endorsed the content of Understanding

Open System in IBS, to guide the mission (CIDB, 2003). One of the main objectives of the roadmap is to introduce Open Building System (OBS) concept by the year 2010. OBS is the long term and systematic approach toward a positive development of building industry. The introduction of OBS will not only reengineer our construction process (supply-chain, trades, design, etc.) but will transform the way of doing business in construction. It allows openness in IBS supply chain where builders can bid for lower price of components. It encourages participation from manufactures and assemblers to enter the market, thus reducing the price of IBS components (CIDB, 2003).

### 3.7. Lose in Tendered Bidding

Tendered bidding is the most popular method in getting a project. The bidding from all the contractor must be clearly described all the quantity and works done in completing the project. With referring to Haron et al. (2005), the lower price offer by the contractor to complete the project will be main criteria before contract awarding. Based on Ghazali (2014), in making a profit in construction activities, the quality of construction is mandatory and can't be negotiated. Nevertheless, with refer to the current practice in Malaysia, the key point of selecting a best tendered bidding is based on the price offered by contractor. With regards on this situation, this is the most critical problems in using IBS component while bidding the price of the project. According to Malaysian Journal of Civil Engineering (2009), it was impossible for contractor to win the tender using IBS price if at the same time other companies were bidding to use conventional price for conventional construction method.

### 3.8. Unreadiness of Globalization Era

According to Ghazali (2014), the next critical factor in IBS plastic formwork adoption and the other component is the attitude of among the stakeholders which involved in the construction field is unreadiness of globalization era. In fact, it was already stated by IBS Roadmap (2003-2010), that it cannot be disputed that to be competitive at the international level, it is important for the Malaysian Construction Industry to evolve and prepared for the globalization era where an increase in productivity, quality and safety is a must (Chung and Kadir, 2007). The uncompetitive in construction can be proved while the total number of registered contractors is only 63,610 nos. That is a phenomenal number if one compares that to the population and it has created a fragmented industry. In this regard, the fragmented construction industries hinder the development of industry-wide information and knowledge sharing. Most of the time, planners, architects and designers interact only minimally among themselves and they as a rule are uncommunicative with the builders and contractors so none benefit from the experience of others (Kamar et al., 2010). Recently, the end products of the construction industry are generally not of a high quality which caused from poor design and build ability, ineffective supervision, lack of skilled manpower, inadequate and inappropriate equipment, financial problems and lack of information at point of use.

## 4. RESEARCH METHODOLOGY

The methodology of the research is by literature review. The search for documentation and discussion involve an extensive



**Table 1: Critical factors for IBS plastic formwork adoption in Malaysia**

Number	Critical factors	A	B	C	D	E	F	G	H	I	J	K	L	Total
1	High Initial Investment Capital		/			/								2
2	Familiarity on Conventional Method	/				/								2
3	Uncompetitive Industry	/	/											2
4	Lose in Tendered Bidding			/					/					2
5	Unreadiness of Globalization Era		/			/								2
6	Awareness on Training and Short Courses					/		/	/	/	/	/		5
7	Awareness on Product Marketability							/	/	/	/	/		5
8	Readiness on Financially Capability							/	/	/	/	/	/	6

IBS: Industrialized building system

review of the current situation in implementation and application of IBS plastic formwork. The information was gathered from the secondary data comprising relevant books, journals, reports, web pages and conference proceedings. It attempts to review the critical factors that contribute to difficulties in adopting IBS plastic formwork.

## 5. DISCUSSION AND FINDINGS

The critical factors of IBS plastic formwork application among Malaysian contractors in Malaysian Construction Industry need to be addressed constantly. The extensive literature review has been done by listing of critical factors and difficulties which affect in adopting IBS plastic formwork.

Based on Table 1, there are 8 numbers of critical factors and difficulties found in the literature review. In detail, the scholars are identified as: A - Chung and Kadir, 2007; B - CIDB, 2003; C -Haron et al., 2005; D - Hong., 2006; E - Kamar et al., 2010; F - Kamar et al, 2011; G - Mirza, 2010; H - Mohamad et al., 2009; I - Rahman and Omar, 2006; J - Majid et al., 2011; K - Yahya and Shafie, 2012 and L - Zawawi, 2009.

It shows that most of the scholars Baharuddin et al. (2015); Chung and Kadir (2007); CIDB (2013); Kamar et al. (2010); Majid et al. (2011); Mirza (2010); Mohamad et al. (2009); Rahman and Omar (2006); Yahya and Shafie (2012) and Zawawi (2009) are strongly agreed that most of critical factors and difficulties should be overcome in order to ensure the successful of IBS plastic formwork adoption.

The discussion of three high numbers of critical factors has been done as follows:

### 5.1. Lack of Awareness on Training and Short Courses

The consensus of the scholars Mirza (2010); Mohamad et al. (2009); Nawi et al. (2011); Rahman and Omar (2006); Yahya and Shafie (2012) and Zawawi (2009) was agreed that this factor has crucial in order to emphasize the IBS plastic formwork implementation. It was also strongly recommended by Ghazali (2014), that stated most of the contractors are not aware with a series of training and short courses which execute by responsible parties due to lack of communication between Malaysian construction stakeholders. It was agreed by Rahman and Omar (2006) that stated contractors and even engineers are not well aware of the IBS system and not involved with the use of any IBS system in their construction methods.

### 5.2. Awareness Product Marketability

According to Ghazali (2014), Mirza (2010); Mohamad (2009); Nawi et al. (2011); Rahman and Omar (2006); Yahya and Shafie (2012) and Zawawi (2009), the majority of respondents agreed that awareness on product marketability is still insufficient among Malaysian construction stakeholders. Based on the pilot study that was execute by Baharuddin et al. (2015), the majority of the stakeholders are not aware with the terms and application of IBS plastic formwork itself due to less information by the responsible parties such as CIDB and others. Since IBS plastic formwork adoption can improve the conventional system especially reducing material wastage and ensure high quality of construction, the company or organization via research and development shall take this opportunity as to widespread the benefit of IBS plastic formwork adoption.

### 5.3. Readiness on Financially Capability

According to Ghazali (2014), Mirza (2010); Mohamad et al. (2009); Nawi et al. (2011); Rahman and Omar (2006); Yahya and Shafie (2012) and Zawawi (2009), the main barriers and challenges of adopting IBS plastic formwork in construction industry is a financial capability which most specific to high initial cost. The consensus of the scholars was agreed that the financial matters would give a huge implication especially in order to execute the agenda. As to emphasize the sustainable agenda by using the IBS concept, the responsible parties of stakeholders should have a strategic planning as to increase the supply chain in the industry with complimentary of great incentives and others.

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