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## Identification of Critical Factors for IBS Plastic Formwork Adoption in Malaysian Construction Industry – A Literature Mapping

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### Abstract

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Industrialised Building System (IBS) in Malaysia has been practiced for decades. The development of its formal practice parallels 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 (CIDB) as an alternative to replace the conventional formwork system but the involvement of 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 adoption in construction industry. The issues related to the *High Initial Investment Capital, Familiarity on Conventional Method, Uncompetitive Industry, Lose in Tendered Bidding, Unreadiness of Globalization Era, Lack of Awareness on Training and Short Courses, Lack of Awareness on Product Marketability, Readiness on Financially Capability* were highlight as a key dimension for the uses of IBS plastic formwork system to success. This paper aims to give new bits of knowledge in IBS formwork to upgrade the application of IBS plastic formwork adoption as well as an alternative solution to enhancing the uses of IBS in Malaysia.

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**Keywords:** IBS; Industrialised Building System; IBS Formwork System; IBS Plastic Formwork System; Critical Factors; Literature Mapping.



## 1. Introduction

Throughout the years, the growth of concrete formwork has been paralleled with the growth of concrete construction. Therefore, it is important to create a good formwork system in order to produce concrete structure. Thus, an intensive study on the formwork commenced. 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 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. In general, conventional formwork is widely used in the construction industry in Malaysia because of its flexibility and easy to produce. This conventional formwork which uses traditional timber formwork that usually built on site out of timber and plywood (Kim *et. al*, 2005). However, Badir et al (1998) found in Ghazali, (2014), was disagreed with that situation which the conventional formworks that are pre-fabricated on site through the processes or timber or plywood formwork installation, is costly for construction, which includes labor, raw material, transportation, low speed of construction time and need to be replaced after a few uses. IBS plastic formwork are made up of lightweight, strong formwork panels that are interlocking and modular in nature, so it can easily 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. Different types of plastic forms are available like glass reinforced plastic, fiber reinforced plastic and thermoplastics etc (Haron et al, 2005). Despite that situation, to overcome the problems of conventional formwork, IBS plastic formwork was introduced and its offered a lot of benefit in terms of sustainable element of formwork such as speed of construction, lower life-cycle costs and almost indestructible. It was agreed by (Thanoon et al, 2003) which also highlighted the benefit of IBS formwork which are cost saving, faster construction time and improvement of overall construction quality which fulfill with the basic goal in the construction industry; time, quality and cost. Nevertheless, based on Ghazali (2014), highlighted that the use of IBS plastic formwork is still minimum. It was justified by Yahya & Shafie (2012), stated that the existing of IBS is to realign and change the paradigm of the conventional construction process which was lack of efficiency.

## 2. Problem and Issues

Based on Zawawi (2009), the application of IBS plastic formwork in Malaysia is still very low by comparing to the other developing country such as United States, United Kingdom and Australia. As 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, found in Ghazali (2014) 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. It also agreed by Kamar et al (2010), which stress out that 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 while 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 and it already worried by (Chung & 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 adoption of IBS in Malaysia (CIDB, 2003). Based on these issues, a gap between critical factors and IBS plastic formwork adoption will given the best possible factor as to improvise the current situation. In general, 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.

### **3. Identification Critical Factors in IBS Plastic Formwork Adoption – Literature Mapping**

IBS formwork is being acknowledged in many writings as contribute to the issues on adoption 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, 2009). A several factors and difficulties that affect the IBS formwork implementation were identified as being difficulty to the implementation:

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

Based on Mohamad (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 & 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 due to lack of involvement in training and short courses regarding IBS course. It was agreed by Yahya & 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, 2009), it only shows that only 50% from the respondent is aware to the various types of IBS references in market. According to Rahman, & 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 & 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, 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 (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, & 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 & 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 & 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 (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 (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 labour, which brings a significant impact on the total cost.

### *3.5. Familiarity of Conventional Method*

Based on Chung & 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 & 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 problem 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 & 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**

This research is to develop the Readiness Framework for IBS Plastic Formwork among Malaysian Contractor in Malaysian Construction Industry. The objectives of this research are firstly, to identify the critical factors that contribute to difficulties in adopting IBS formwork, secondly, to develop a conceptual of readiness framework by the importance criteria from the relation between critical factors. For this paper only the first objectives are discussed. The development of critical factor was confined to the literature published from 2003 onwards in academic journals and published proceedings. A thorough examination was carried out in order to develop in depth-understanding about which factors are likely to happen due to IBS plastic formwork adoption.

## 5. Discussion of Findings

According to Ghazali (2014), stated that is required to overcome the barriers and critical factors for IBS Plastic Formwork adoption as to support the government target in increasing the percentage of using IBS components. The extensive literature review has been done by listing of critical factors and difficulties which affect in adopting IBS Plastic Formwork. In general, there are eight (8) numbers of critical factors and difficulties found in the literature review. Based on Table 1, there are several critical factors and difficulties in adoption of IBS Plastic Formwork in construction industry. In detail, the scholars can be identified as A (Chung & Kadir 2007); B (CIDB, 2013); 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 & Omar, 2006); J (Majid *et al.*, 2011); K (Yahya & Shafie, 2012) and L (Zawawi M., 2009). It shows that most of the scholars Baharuddin et al (2015); Chung & Kadir (2007); CIDB (2013); Kamar et al (2010); Majid et al (2011); Mirza (2010); Mohamad (2009); Rahman & Omar (2006); Yahya & 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 (3) high numbers of critical factors has been done as follows:

**Table 1.** Critical Factors for IBS plastic formwork adoption in Malaysia.

No	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

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

The consensus of the scholars Mirza (2010); Mohamad (2009); Nawi et al (2011); Rahman & Omar (2006); Yahya & 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, A. B. A., & Omar, W. (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 & Omar (2006); Yahya & 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 executed 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 & development (R&D) 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 (2009); Nawi et al (2011); Rahman & Omar (2006); Yahya & 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.

## 6. Conclusion

The critical factors of IBS plastic formwork adoption among the Malaysian contractor in the Malaysian Construction Industry need to be addressed constantly. Based on previous research and literature mapping; it was shown that issues related to the *High Initial Investment Capital, Familiarity on Conventional Method, Uncompetitive Industry, Lose in Tendered Bidding, Unreadiness of Globalization Era, Lack of Awareness on Training and Short Courses, Lack of Awareness on Product Marketability, Readiness on Financially Capability* were highlight as a key driven on the less usage of IBS plastic formwork in Malaysia. This variable are require for further investigation in order to confirm its validity. Therefore, an analysis of this empirical literature review will help to shape a framework or structuring model for enhancing the uses of IBS plastic formwork system among Malaysian contractors.

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