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Constraints in Implementation of Industrialised Building System (IBS) Project: Contractors' Perspective

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Abstract

Every industry in a country is attempting to adopt all of the sophisticated technology that is available in conjunction with the advancement of technology. Abruptly, the establishment of the Construction Industry Master Plan (CIMP) has resulted in initiatives in the implementation of innovative approaches towards a sustainable construction environment via the Industrialised Building System (IBS). However, since the first IBS project in 1964 until today, IBS in Malaysia has been poorly accepted by construction parties due to a failure to adequately manage risks in IBS projects. Therefore, this study aims to focus the contractor's perspectives on the constraints of IBS implementation in order to assist contractors in their decision-making towards achieving effective project delivery. This study employed a quantitative approach. 85 questionnaires were distributed to local contractors (G1 to G7) that specialised in IBS project and 45 respondents the questionnaires. The results were analysed using the SPSS version 28 and descriptive statistical analysis. According to the results of the analysis, respondents agreed that the main five (5) constraints in implementation of IBS project were high initial cost, required high skilled labour, fluctuation of raw material price, lack of technology implementation and lack of financing.

Keywords: Industrialised Building System, Constraints, Contractors' Perspective

Research Background

Industrialised building system (IBS) is one of the innovations adopted in the construction sector. According to Nasir et al (2016), mentioned that IBS is labelled as an on-site building activity that consists of methodologies, products, and a collection of interconnected components that work concurrently to accomplish a construction project's goal.

In Malaysia, the implementation of IBS started way back in the 1960s. But during that time, the implementation of IBS is not as wide as these days. In the 1960s, the IBS system used to solve a severe housing problem (Din et al., 2012). However, there are still issues regarding changes in the direction of adopting new construction technologies. The IBS Roadmap 2003-2010 was introduced in 2003 to promote IBS in the effort to reduce dependency on foreign site operatives, improve governance and integrity of management on site, whilst advancing towards a more systematic approach to construction (Jabar et al., 2019).

Nonetheless, IBS adoption in the Malaysian construction industry remains very low, with only 15% of Malaysian projects implementing IBS (IBS survey, 2013). Only 24% of IBS public construction projects worth RM10 million or above obtain 70 IBS scores, while private IBS projects with 50 IBS scores received only 14% in 2014. (Pang, 2016). Malaysia's construction industry must address any issues that might prevent or deter someone from implementing IBS as a construction method. To assist with this situation, the government should provide additional incentives to IBS manufacturers and contractors. Furthermore, transitioning to IBS necessitates extensive planning and political commitment. There will undoubtedly be opposition to IBS adoption (Wong, 2020).

Literature Review

Players who lack knowledge are unable to see the benefits that new technology has to offer. In IBS, many factors must be considered in order to fully appreciate what the technology has to offer. According to research conducted by Nawi et al (2011), the intense competition among construction industry players in using the conventional method of construction causes some groups to point out that this is one of the reasons why IBS is still expensive. Construction using IBS is more expensive, which is why most construction industry players are still hesitant to use IBS in their construction method (Nawi et al., 2011). Authorities' lack of knowledge can also lead to misunderstandings in current building and IBS regulations (Kamar et al., 2009).

A lack of incentive or promotion from the authorities can also limit the use of the IBS in the construction industry. Due to a lack of IBS branding and promotion in the market, the end user is unlikely to misunderstand or be unaware of this building approach. As a result, IBS lacks sufficient pull factors to entice developers to use it. In contrast, IBS development in Scandinavia and Japan is more client-focused, with mass-customization used to broaden customer options (Kamar et al., 2009). As a result, an appealing incentive or promotion can assist in attracting more construction industry players to adopt the IBS system. The government plays a significant role in the implementation of IBS because they have both pull and push factors (Din et al., 2012).

Another barrier associated with the constraint in implementing the IBS is the high initial cost. Several factors can contribute to the high initial cost. According to Dzulkalnine et al (2016), the high initial cost is a result of setting up the factory in order to implement the IBS. The IBS contractor must pay an up-front payment of up to 30% or more. The majority of the factors that contribute to the high initial cost include purchasing new machinery, training labour, purchasing new equipment, and purchasing all of the necessary equipment to begin production. Not only did the IBS contractor require a high initial cost, but so will the contractor who will carry out the construction work. This is due to the fact that the contractor will have to pay the suppliers in order to obtain the components. This issue arises also because current procurement structures necessitate a large initial capital investment by the contractor (Ashraf et al., 2017).

Chung (2006); Nawi et al (2005), as cited in Nawi et al (2011), that the distance may have increased the cost of transportation and components, particularly if the construction project is located in a remote rural area. This situation arises because many manufacturers prefer to locate their factories in urban areas where all types of industry associations are active. This was also mentioned late in 2000 by IBS Manufacturers Directory (2008), as cited in Nawi et al (2011), who stated that most IBS manufacturers set up their factories in industrial areas such as Klang Valley, Seremban, or Butterworth. This issue was raised again by a respondent in research by (Ali et al., 2018), where the respondent stated that they will have to pay an additional cost for transportation due to the IBS manufacturer's location being far from the site. Besides that, Dzulkalnine et al (2016) stated that the price of the raw material change every three months which can affect the cost of the production. Furthermore, the higher the cost of the materials it will simultaneously increase the initial cost of the production leading to the difficulty of the contractor to maintain the steadiness of the profit.

According to Hamid et al (2008), as cited in Kamar et al (2009), IBS acceptance is hampered due to a lack of R&D, low information technology (IT) adoption, and limited technological availability. This issue was raised again by Ashraf et al (2017), who stated that more support from stakeholders and construction companies in the sector is required to accelerate the deployment of IBS. Because this new construction concept incorporates a lot of cutting-edge technology, construction experience is very important. As a result, the faster technology is adopted in IBS production, the less restrictive IBS implementation will be.

The existing construction worker training programme is still unable to meet the high market demand (Mohamad Kamar et al., 2009). Not only that, but IBS necessitates specialised and semi-skilled labour, with unskilled labour being rare. Malaysia, for example, employs a large number of Indonesian, Bangladeshi, and Pakistani labourers in the construction industry. It is critical to emphasise that labourers are still required to send for IBS-related training. This is to ensure that the worker's quality is guaranteed in order to avoid future problems (Saggaff, 2017). Furthermore, all of the aforementioned reasons will raise concerns among contractors because sending labourers for training can take time and money.

The industry has yet to fully grasp the concept of Supply Chain Management (SCM) and collaboration. Collaboration between contractors, manufacturers, and suppliers is now lacking in many cases. Improving the procurement system and supply chain is critical to contracting organisations' IBS success (Din et al., 2012). This situation could cause a delay or other issues during the construction process. This is due to the fact that IBS manufacturers are typically located in industrial areas. As a result, if the construction is to be done in a rural area, transportation to the site may become a problem, as will the travel distance. As a result of this situation, the unfortunate contractor will have to incur additional logistics and transportation costs in order to deliver the IBS components to such a location. This has been identified as one of the most significant barriers to IBS implementation in the Malaysian construction industry (Ali et al., 2018).

Malaysia is an equatorial climate country which means a tropical climate. Every year, duringthe monsoon season, this country receives a lot of rain. This contribute to leakage problem, which is a serious issue in buildings built with IBS applications. When a leak occurs, it can lead to further issues such as moisture, corrosion, and other issues (Mydin et al., 2014). Thisis supported by Ali et al (2018) through a respondent mentioning that because of the weak jointing between the precast part and the in-situ structure, the IBS system has an unfavourable reputation. Thus, this shows that the jointing between the IBS component is very crucial in order to avoid any problem or issue in the future. This issue already being mentioned earlier in 2000 by Thanoon et. al (2003a); Nawi et. al (2007b) as cited in Nawi et al (2011) stating that several prior studies have found that one of IBS's flawsis its laborious connections and jointing methods, which can lead to mistakes and shoddy work.

According to Pan et. al (2004), as cited in Jabar et al (2013) the IBS construction process was further hindered by site peculiarities or limits, as IBS components necessitated additional room for storage, mobilisation, and circulation of machinery and equipment. This also will discourage the industry players to adopt the IBS because of the difficulties to store the component. If it is not being store properly, the component might be damaged either by the weather or the workers on-site. Ineffective ways to store the components also might lead to double handling of the products, causing delay which simultaneously will have an unfavourable impact on the cost of operations, quality, and the time it takes to complete the project (Jaffar & Lee, 2020).

This issues already being mentioned by Warszawski (1999) stating that the technology, organisation, and design of prefabricated building systems were never an intrinsic componentof engineers' and architects' professional knowledge, which was acquired as a subject in a standard academic curriculum. Academic curricula rarely feature courses that convey the promise and problems of industrialisation in a thorough and scientific manner. Students should be taught structural design principles, material technologies, and building procedureslinked to IBS systems such precast concrete structures at the university level (Warszawski, 1999). Aside from that, testing and study are required to demonstrate the design's feasibility.Advanced research knowledge may improve one's grasp of the behaviour of the IBS structureand, as a result, one's confidence (Abd Rahman & Omar, 2006).

It comes with a lot of reason such as lack of experience in risk management can expose the construction industry to risk due to the lack of experience from the parties involved in the construction (Rashidi & Ibrahim, 2017). Unknown hazards in IBS initiatives might result in significant risks and project failures. This is observed later by Kasim et al (2019) finding that there are no specific cost control mechanisms used by contractors in IBS, and there is a lack of adequate project management approaches, specifically for IBS. Besides, according to Nasir et al (2016), management in term of financial also very important. This is because, poor financial management can interrupt the flow of the project which can lead to delay or incompletion of the construction product.

Small contractors are already accustomed with the traditional method and the technology suitsthem well for modest jobs, so they are hesitant to move to a mechanised system (Abd Rahman& Omar, 2006). Furthermore, small contractors lack financial backing and are unable to establish their own production units due to the high capital investment required. In this situation, small contractors' financial concerns become the primary impediment to implementing the IBS system (Abd Rahman & Omar, 2006). This is backed by (Nasrun et al., 2015b) affirming that small contractor most likely does not have enough financial capabilitiesin order to use the IBS.

Standardization should be considered when designing an IBS system in order to achieve a workable system. Standardisation can include the use of standard connections, beam and column sizes, and so on. Component standardisation may be implemented to reduce manufacturing costs. The manufacturing of the components is the toughest aspect of creatinga viable system. For example, the steel mould used to form beams and columns must be extremely precise in order to produce accurate and consistent width, breadth, length, and otherrelated dimensions (Abd Rahman & Omar, 2006). This is being mentioned again by Alawag et al (2021), founding that according to studies, the majority of local professionals and contractors lack technical knowledge and experience with IBS methods also contribute to thislimitation.

The most significant disadvantage of prefabrication, preassembly, and modularization in construction is the lengthening of the pre-project planning stage (Lu, 2007). There is a need for more engineering effort to be put in at the start. As a result, prior to fabrication, design work and extensive planning must be carried out precisely. Furthermore, design, transportation, and on-site installation must all be coordinated for a successful implementation(Lu, 2007). This is supported by Arashpour et al (2015); Hwang et al (2018) mentionedthat since off-site operations are often carried out by trades with individual specialisation without the necessary coordination to prevent work shortages in the production system making detailed coordination is required at all stages of a project.

Methodology

This study used quantitative data approach. Because the purpose of this research is to discover why IBS is still not widely used in the construction industry, the targeted respondents include all construction industry players. The study sought 85 respondents in total, with a focus on Local Contractor Grade one (1) through Grade seven (7) specialising in IBS in Kuala Langat, Selangor. According to Sekaran and Bougie (2016), the most appropriate sample sizes for most research should be greater than 30 and less than 500 respondents. However,for several reasons such as the Movement Control Order (MCO), 45 respondents were successful in collecting the online questionnaire through Google Form or Email. Any incomplete or unacceptable response is eliminated after all data has been collected. Any ambiguous data is corrected and edited before being processed and reviewed to meet the research objective. The data were analysed using the Statistical Package for Social Science (SPSS) software version 28.

Analysis and Discussion

Based on Table 1, nineteen (19) factors were identified as constraints in the implementation of IBS project which has been collected from the literature review. Mean and standard deviation have been calculated and the ranking of these factors has been dones to determine the most critical constraints in the implementation of IBS project.

Table 1
Constraint in Implementation of IBS Project

Factors	Rank	Mean	Std. Deviation
1) High initial cost	1	4.31	.925
2) Required high skilled labour	2	4.18	.860
3) Fluctuation of raw material price	3	3.98	.941
4) Lack of technology implementation	4	3.93	.939
5) Lack of adequate financing	5	3.89	1.005
6) Supply Chain Management (often delay in delivering the component)	6	3.84	.928
7) Lack of Involvement Among Small Contractors	7	3.80	.968
8) The distance of the factories from the construction site	8	3.78	1.064
9) Problem in the jointing of the components	9	3.76	.981
10) Payment issue (Client late issue payment to the contractor)	10	3.73	.963
11) Lack of incentive or promotion from the Authorities	11	3.71	.920
12) Absent of Syllabus in Universities	12	3.64	.883
13) Long-term coordination work is required.	13	3.64	1.048
14) Poor project management approach	14	3.60	.915
15) Design Limitation	15	3.60	1.268
16) Lack of guarantee regarding the continuality of funding during the construction process	16	3.58	1.076
17) Problem to obtain loan from financial Institution	17	3.53	1.036
18) Lack of knowledge	18	3.53	1.036
19) There are not enough spaces for storage area at site	19	3.42	1.076
Valid N (listwise)	45		

Notes: Strongly disagree = 0.00<AI<1.50, Disagree = 1.50<AI<2.50, Neutral = 2.50<AI<3.50 Agree =3.50<AI<4.50, Strongly agree = 4.50<AI<5.00

According to the Table 1, the result of the survey indicates that eighteen (18) factors were agreed by the respondent whilst one (1) factor was undecided by the respondents. The highest mean index is high initial cost (m=4.31), followed by required high skilled labour (m=4.18), fluctuation of raw material price (m=3.98), lack of technology implementation (m=3.93) and lack of adequate financing (m=3.89). Thus, the lowest mean index is lack of knowledge (m=3.53) and not enough space for storage (m=3.42), which were not considered as relevant to the contractors.

The first-ranked factor of constraints was high initial cost, which is aligned with the finding by Dzulkalnine et al (2016) stated that the high initial cost is a result of setting up the factory in order to implement the IBS. The majority of the factors that contribute to the high initial cost include purchasing new machinery, training labour, purchasing new equipment, and purchasing all of the necessary equipment to begin production. Next factor was high skilled labour, which supported by Idris Din et. al (2012) agreed that the construction industry has started to improve the quality and productivity of construction by reducing the problems of skilled workers and reliance on foreign manual labour.

The third factor ranked as the constraint in IBS was the fluctuations of raw materials price. It is aligned with the finding by Dzulkalnine et al. (2016) stated that the price of the raw material change every three months which can affect the cost of the production. Furthermore, the higher the cost of the materials it will simultaneously increase the initial cost of the production leading to the difficulty of the contractor to maintain the steadiness of the profit.

Conclusion

The objective of this research paper had been achieved by rank of mean for each factor listed. As a result, the main five (5) constraints in the implementation of IBS project were high initial cost, required high skilled labour, fluctuation of raw material price, lack of technology implementation and lack of financing. This research analysis revealed that high initial cost is the most critical constraint in the implementation of IBS project. The high initial cost has burdened the players in the IBS project because they require a large investment for the IBS project. It becomes a main challenge to the IBS contractor to run the project. Therefore, it is recommends that more intensive researches emphasise on how to mitigate these nineteen factors of constraint in the future.

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