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Perception Analysis of Industrialized Building System (IBS) Implementation for G7 Contractors in Kuching, Sarawak

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Industrialized Building System (IBS) is one of the initiatives underpinning the green construction zeitgeist. A myriad of advantages can be associated with adopting IBS in construction, including inter alia, improved construction quality and productivity, minimisation of construction waste, optimisation of construction materials on-site, enhanced environmental sustainability, and many others. In spite of these advantageous propositions, there is exist a gap in the exposure towards IBS construction methods, particularly in the city of Kuching, Sarawak, as compared to more familiar conventional methods. Thus, the purpose of this study is to identify the issues and challenges experienced by contractors in their IBS endeavour as well as to propose a framework of solution. Moreover, this study investigated the impact of IBS adoption by G7 contractors registered with the Construction Industry Development Board (CIDB) of Sarawak. Data of this study was collected via questionnaires distributed to the G7 contractors and subsequently analysed using descriptive and mean analysis. Results obtained from the study suggested that IBS construction method enhances the efficiency of construction for speedier completions, which recorded the highest ranking. Conversely, lowering the costs of construction through optimisation of materials registered the lowest ranking, suggesting that contractors do not necessarily perceive IBS as having a cost-saving ability. This study showed that IBS helps to improve the efficiency of the construction process. However, respondents were still uncertain that adopting IBS can reduce costs. This corresponds to the finding in which the most significant challenge perceived by the contractors was related to cost. This suggested a lack of integration between the different stakeholders, especially during the design stage, often resulting in the need for redesign works that required additional costs when IBS is to be adopted. In this regard, it was not a surprise to find that "promotions" obtained the top ranking as a solution in overcoming the IBS challenges. Hence, support from both the government and the private sector needs to be garnered and diligently promoted, so that the adoption of IBS in the Sarawak construction industry can be properly enhanced.

Keywords: construction industry; Industrialized Building System; G7 Contractors; Kuching

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I. INTRODUCTION

Industrialized Building System (IBS) is one of the initiatives underpinning the green construction zeitgeist. IBS is also one of the preferred construction systems in attaining the goal of faster project delivery. The implementation of IBS has been diligently promoted by the Construction Industry Development Board (CIDB) for many years. IBS can be defined as construction systems in which structural components are manufactured off-site, commonly in a factory, and subsequently transported to the final location to be assembled into the complete structure. This method requires significantly less work on-site. Developed countries such as Finland, Denmark, the Netherlands, Singapore, England, and the United States have successfully implemented IBS for decades.

In this instance, many advantages can be associated with IBS. Since the structural components are produced in the factory, plenty of processes can be automated, and hence, the requirements for manual workers can be minimised. Likewise, quality control is also much better with higher aesthetically pleasing end products manufactured through meticulously planned production processes and expounded installation methods. Besides, the demands for conventional building materials on-site such as timber formworks can be lowered by replacing them with pre-fabricated components or other modern moulds that allow repetitive applications. Moreover, the reduction of construction waste with the adoption of standardised components can also serve as a good way of promoting sustainable construction. Lastly, the reduction of on-site workers, materials and construction waste through IBS construction method would create much safer construction sites, mitigating the risk for accidents and injuries.

Significantly, IBS is now new in Malaysia. In year 1966, two dwelling projects that paved the way for IBS construction method were the construction of the Pekililing apartment in Kuala Lumpur as well as the construction of the Rifle Range apartment in Penang. Thereafter, numerous mega-projects such as the infamous Petronas Twin Tower, the Bukit Jalil International Sports Complex and the Malaysian Light Rail Transit also deployed the IBS. In Sarawak, a couple of building projects too embraced the IBS, namely the Private Residential House at Kampung Gita, the worship place of Surau Kampung Kudei, and the training centre of Institut Aminuddin Baki at Santubong.

The Sarawak construction industry has openly welcomed the IBS concept, but for some reasons, the adoption rate is much slower as compared to its Semenanjung counterparts and is still considerably far behind from the targetted level envisaged through the IBS Roadmap 2011-2015. As a recapitulation, the afore-mentioned roadmap was endorsed by the Cabinet as the blueprint for industrialisation of the Malaysian construction industry. The main objective of this roadmap was to significantly reduce the reliance on unskilled foreign workers while at the same time improving the quality, productivity, safety and compatibility of construction projects that adopt IBS (Construction Industry Development Board, 2010). Based on Mohd Bohari *et al.* (2012), IBS is still considered new to most of the contractors operating in Sarawak and this suggested a serious lack of exposure to IBS. Consequently, these contractors were quite deficient in their method. Many contractors admitted that IBS will improve the remittance of the project, however, the lack of volume to use IBS economically is the main obstacle in the implementation of IBS, particularly in Sarawak. Various setbacks of IBS implementation were suggested such as resistance to change, negative perceptions of the stakeholders toward IBS designs, higher overall construction costs, lack of knowledge and exposure to IBS technology, and lack of IBS manufacturers in the industry (Hadi *et al.*, 2017). It was also suggested that the considerable volume to adopt IBS economically in construction projects had become one of the critical pitfalls of IBS performance in Sarawak.

Even though the state government has been strongly encouraging construction players to implement IBS, the level of adoption is still worryingly low. Therefore, this study aims to shed light on the appropriate approaches in tackling the challenges of IBS adoption in Sarawak. It is hoped that this study will serve as a solid starting point to assist IBS registered contractors in facing the challenges ahead and in managing the associated risks. The outcomes of this study are expected to raise awareness on the issues pertaining to IBS implementation and eventually to expand the possibilities of successful adoption, including disseminating them as parameters for future development and construction plans.

II. MATERIALS AND METHOD

A. Instrument Development

Close-ended questions were developed for the questionnaire adopted in this study. In this instrument, there were four (4) sections:

SECTION A: Demographic Information;

SECTION B: The Impact of Industrialized Building System (IBS) adoption in construction projects;

SECTION C: The Challenges of IBS Adoption in Construction Industry that were faced by G7 Contractors in Kuching, Sarawak;

SECTION D: The Proposed Solutions in Overcoming the Issues/Challenges in the Adoption of IBS method.

SECTION A consisted six (6) questions designed to elicit the demographic profile of the respondents, which includes age, gender, position in the company, area of expertise, years of experience in the construction industry, etc.

SECTION B, SECTION C, and SECTION D focused on the research objectives. SECTION B identified the impact of IBS adoption in construction projects through nine (9) questions. Next, eight (8) questions SECTION C investigated the challenges of IBS adoption in construction industry faced by G7 contractors in Kuching, Sarawak. Finally, five (5) questions in SECTION D identified the solutions perceived by the contractors in overcoming the issues and challenges in the IBS adoption.

B. Sampling Method

The population for this study was identified as G7 contractors in Kuching registered under CIDB Malaysia. In particular, this study focused on G7 contractors who had been involved in IBS. The calculation to determine the required sample size is tabulated by Krejcie and Morgan (1970) as illustrated in Table 1.

Table 1. Required sample size

Type of IBS	Registered in CIDB	Required sample size
Steel frame system	178	117
Timber frame system	4	4
Block work system	3	3
Precast concrete system	63	54
Formwork system	3	3

III. RESULT AND DISCUSSION

A. Demographics

1. Age

The analysis indicated that the age group of 21 to 30 years old recorded the highest percentage with eighty (80) respondents (60.2%). Meanwhile, respondents in the age of 31 to 40 registered the second largest group with thirty-eight (38) frequencies (28.6%). There were 10 respondents from 41 to 50 years old (7.5%) and the smallest group was respondents with the age of more than 51 years at only 5% of the sample.

2. Level of education

There were four levels of educational qualification identified in the study. The highest-ranked level was for Bachelor's Degree with 56.4% of the respondents, and the second-highest ranked level was for Diploma with 36.1% of the respondents. Other than that, 6.8% of respondents indicated they were qualified with a Master's Degree, and only 0.8% acquired other levels of education such as Sijil Pelajaran Malaysia (SPM).

3. Area of expertise and working experience

Five (5) areas of expertise were identified including Construction Management, Contract Administration, Planning Management, Site Management and Site Supervision and Others. 42.1% of respondents responded as Construction Management. In the meantime, Contract Administration, Planning Management, Site Management and Site Supervision recorded proportions of 36.1%, 29.3%, 33.8% and 21.1%, respectively. Some other area of expertise included Laboratory, QAQC, Safety Department and Surveyor Department.

For years of working experience, 54.1% of the respondents had below 5 years of experience, indicating most of them were freshly graduated. On top of that, 28.6% of respondents indicated they had 6 to 10 years of working experience, while 11 to 15 years and 16 to 20 years recorded 8.3% and 3%, respectively. Only 6% of respondents had more than 20 years of working experience.

4. Position in company

Based on the survey, 6% of respondents were positioned as Project Manager and Quantity Surveyor, while 7.5% were Project Engineer. In addition, Site Supervisor and Design Engineer stood at 4.5% and 3.8%, respectively. Interestingly, most respondents (72.2%) specified others as their position in their company which included secretary, admin executive, site engineer and document controller.

B. The Impact of Industrialized Building System (IBS) Adoption in Construction Project

The analysis revealed that the majority of respondents agreed that IBS can help to improve the efficiency of the construction process, which saves productivity, quality, time and costs. This is summarised in Table 2. This finding lends support to previous study by Wong and Lau (2015) in which IBS method was found to provide faster project completion. IBS components are factory-produced and thus only require minimum installation works on-site as compared to those time and labour consuming conventional activities such as setting-up of formwork. Furthermore, most of the respondents also strongly agreed that IBS improves the safety and neatness of the construction site, minimising site wastages and is more environmentally friendly compared to traditional methods. This impact was ranked as the second highest.

Moving on, the respondent agreed that the adoption of IBS can reduce labour on-site. IBS method can reduce the reliance on foreign labour and unskilled workers and this can significantly reduce the labour cost for contractors. Besides, the quality of work can be enhanced, leading to savings on rework cost which can be attributable to the outputs of unskilled workers.

Next, higher quality control and better finishes ranked fourth in the analysis. IBS components are produced and fabricated in factory in a controlled environment with better material selection utilising highly mechanized technology. The activities on-site are less likely to be affected by adverse weather since IBS components are pre-fabricated off-site, thus, there will be minimal delay in construction as the fabrication is done within a controlled environment.

However, in this study, lower costs have been recorded as the lowest ranked impact where most respondents perceived uncertainty that the IBS method could lower the construction costs through materials and labour optimisation. This suggest that many contractors still have the tendency to believe that IBS required higher cost in its implementation.

Table 2. Impacts of IBS adoption

Impacts	Mean	Rank
Enhance the efficiency for faster completion - save productivity, quality, time and costs.	1.2256	1
Reduce labour on site - IBS component will automatically lower the usage of foreign labour and reduce labour demand.	1.3534	3
Clean site conditions and reduced health & safety risk - IBS increase site safety, neatness, minimal wastage and environment friendly.	1.2932	2
Higher/control quality and better finishes – IBS promotes quality and productivity because the components are produced in the factory.	1.3759	4
Lower costs – optimized use of materials and labour.	1.5338	6
Construction operation less affected by weather – pre-fabricated and assemble in site	1.3910	5

C. The Challenge of IBS Adoption

Based on the analysis, cost was identified as the highest ranked challenge associated with IBS adoption. Remarkably, this corresponded to the afore-mentioned result where respondents perceived lower costs of construction as the least significant impact of IBS adoption. Even though IBS command a high initial investment, contractors should realise that the management and labour costs can be reduced at a later stage through the implementation of IBS.

Besides that, the lack of financial support to set up their own manufacturing plants in Malaysia, especially in Kuching, Sarawak, has been identified as one of the barrier to IBS implementation. Not only that, most of the G7 contractors were already familiar with the current system and possessed inadequate budget for mechanised construction systems.

Consequently, the IBS projects awarded were not well managed and buildings of poor quality were produced (Abdul Khalil *et al.*, 2016). Another possible factor for the bad reputation of IBS is that IBS component manufacturing is often only decided after the value-chain tendering stage. This lack of integration in the design stage between the relevant stakeholders resulted in the need for costly redesign if IBS is to be adopted (Abdul Khalil *et al.*, 2016).

The lack of knowledge ranked as the second highest challenge in IBS adoption for the G7 contractors in Kuching, Sarawak. This can be ascribed to the poor knowledge of both the structural analysis and the design of prefabricated elements. Accordingly, most of the current construction players are unwilling to switch over from the familiar conventional construction system because of the lack of knowledge (Abdul Khalil *et al.*, 2016). Furthermore, negative perceptions also contributed to the low level of IBS implementation. Rahman and Omar (2006) reported that owing to past failures as well as more attractive architectural designs, the term IBS was commonly associated with negative perceptions. Additionally, limited enforcement on the requirements of IBS also discouraged construction players in the adoption of IBS. Despite the tremendous efforts that the government has poured in to encourage the adoption of IBS in Malaysia, the trend of IBS implementation painted a contrasting picture, where the target sets were still far from achievable. Nevertheless, a number of IBS specialised contractors still adhere to the IBS requirements enforced in Malaysia. It is clear that IBS requires a paradigm shift and a new set of management practice to achieve its desirable outcome when undertaking the IBS project.

The lowest ranked challenge is in relation to planning and implementation where IBS requires good planning in terms of production, transport and installation on-site. This suggests that contractors did not perceive additional planning as a challenge toward IBS adoption in Sarawak. The ranking of the perceived challenges can be illustrated in Table 3.

D. The Propose Solution in Overcoming the Challenge in Adoption of IBS Method

Based on the findings, promotions or so called publicity through various authorities, parties and media was the highest ranked solution among the five proposed solutions in overcoming the issues or challenges of IBS adoption. The implementation of IBS needs to be promoted by both the government and private sector to increase the adoption of IBS.

Table 3. Challenges of IBS adoption

Issues/Challenges	Mean	Rank
Lack of knowledge – poor awareness program for better education contribute to the customer's interest.	1.3910	2
Negative perception – linked to low building quality, some leakage, neglected construction, miserable architectural aspects and much more.	1.4135	3
Planning and implementation - IBS require good planning in terms of production, transport, installation on site.	1.4887	4
Limited enforcement of IBS requirements – execution process of IBS was trusted not strongly implemented.	1.4135	3
Costs – thought that IBS need high demands of investment.	1.3684	1

Incentives and promotions provided by the government could be reviewed from time to time and subsequently increased to encourage more construction players in adopting the IBS method. Lack of experience from contractors in managing IBS projects is also one of the critical constraints that they faced when entering this field.

In February 2009, aggressive promotion on IBS through the media and the Malaysian International IBS Exhibition (MIIE) gave much input on this element. However, currently the target of IBS is still on the lower level. Most of them are still unaware of the availability of different IBS references and short courses provided by CIDB to support the implementation of IBS (Yahya & Shafie, 2012).

Another proposed solution is by bringing the manufacturing practice into construction. Most of the respondents agreed to this proposed solution because it is essential for IBS design to obtain manufacturing input at an early stage of the project. It is crucial for IBS adopters to involve the project team as early as possible in the design

phase to ensure that their inputs on manufacturing, design harmonization and constructability are adequately captured before the design is finalised and transferred to the manufacturing floor (Abd Hamid *et al.*, 2011). The intensified training in the skills of IBS such as system integration or assembly is needed to improve the efficiency as IBS method requires a high level of precision in construction. Studies have shown that the majority of local professionals and contractors lack IBS technical knowledge and experience. Under this system, there is less demand for manual labour on-site especially for carpenters, bar benders and concreters. The system requires more machine-oriented skills, on sites as well as in factories. This leads to a transformation that requires an organisation to restructure human resources in terms of education and training.

Furthermore, to improve the uptake of IBS adoption, designing a feasible IBS is imperative, so as to form the optimum size and shapes of the components for standardised production. Thus, modular coordination and standardisation are among the characteristics required to determine the successful implementation of IBS. Waleed *et al.* (2003) presented that in order to meet modular coordination requirements, all IBS components should be standardised and therefore, standard plans and component drawings are a must to support the production process. Otherwise, even partial introduction of IBS components such as lintels or staircases will not be viewed favourably and consequently will be hard to adopt, stemming from a lack of modular coordination. Lastly, it is through constant education and life-long-learning seminars, that IBS can be improved regularly and ultimately enlarging the positive perception of IBS method. Educational bodies should take up the leading roles in providing the theoretical and technical knowledge to both freshly graduated as well as practicing engineers so that they are well-versed in IBS designs that can be readily implemented in the construction industry. The ranking of proposed solutions in overcoming the challenges of IBS adoption can be summarised in Table 4.

IV. CONCLUSION

This study offered empirical evidence that the majority of contractors perceived IBS could enhance the efficiency of construction for faster project completion. The most significant challenge faced by G7 contractors in Kuching, Sarawak in the high initial cost of IBS adoption. This corresponded strongly to the findings in which contractors perceived lowered cost as the least significant impact of adopting IBS. Upon this challenge, the most preferred solution was to intensify promotional or publicity efforts for all players in the Sarawak construction industry via proper education on the effectiveness of IBS, as well as to increase the incentives for adopters of IBS. Only then, the implementation of IBS in Sarawak will witness a renewed acceleration in accordance with the framework of Industrial Revolution 4.0.

Table 4. Proposed solutions in overcoming the challenges of IBS adoption

Propose Solution	Mean	Rank
Education and seminar – this need to be improve and enlarge the good perception of using IBS method.	1.4361	5
Training – Intensified training in the skills of IBS such as system integration or assembly.	1.3383	3
Designing a feasible of IBS – form the achieved standardised size and shapes	1.4286	4
Bring the manufacturing practice in construction – to implement IBS, manufacturing principles is along the process.	1.3233	2
Promotions – the implementation of IBS need to be promoted either from government of private sector for increasing the adoption of IBS.	1.3008	1

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