Hybrid System Method of Industrialised Building System (IBS): A Review of Studies

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Abstract. A new technology in construction has implemented Industrialised Building System (IBS) as an adoption of a new method. Till date, the reception of Industrialised Building System (IBS) has been effectively advancing by Construction Industry Development Board (CIDB). Several of exertions have been taken, for example tremendous of research financing, preparing, and building up standard and other showcasing plan. From previous writing and industry report, the appropriation of IBS was practiced gainful to improve the construction quality and profitability and spare expense and also the duration of completion projects. However, there are still a few issues and problems, such as supply chain and design drawing issues, which has always been one of the biggest problems that should be taken care of in the construction industry. Nowadays, Industrialised Building System (IBS) also has been modified in many ways to make it more practical to use in the construction field. The IBS usage becomes a trend and also a requirement for a government project especially in the northern region of Malaysia such as Kedah and Perlis. Hence, this paper focuses on latest review which is about the new method implements in Industrialised Building System (IBS) technology, which is known as a Hybrid System method. This system is not yet to be found since it is one of the pilot projects from the government. Thus, the survey for this paper will evaluate the outcome whether the new Hybrid System method leads to delay in Industrialised Building System (IBS) or it can help to improve the deferrals of construction.

1. Introduction
Construction is one of the biggest field in industry and nowadays there are so many ways that have changed the industry in order to implemented new technology. In perspective on gathering the administration's desire to change the Malaysian development industry into utilizing the cutting edge technique of development and to assist the usage of the Industrialized Building System (IBS) Roadmap and Construction Industry Master Plan (CIMP) 2006-2015, there is a call for the business players for a legitimate and organized arranging and usage system for IBS to be set up [1].

In the year 2008, a roundabout from the Malaysian Treasury Department of the Ministry of Finance indicates that the arrangement on full usage of IBS to be forced for all administration extends in Malaysia [2]. Construction Industrial Development Berhad, CIDB (2010) had impelled second IBS Roadmap 2011-2015 to replace the current guide (IBS Roadmap 2004-2010) began in late 2010.

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A considered had been finished by Blimas and Wakefield (2008)[3] expressed that the conventional development process is unsatisfactory for Offsite Manufacturing (or IBS development) and represents a significant obstruction to its selection [3]&[4]. The findings has been supported by other previous studies CIDB (2009)[2], Mohd Kamar & Alshawi (2009)[5] & Nawi, Jalaluddin, Zulhumadi, Ibrahim, & Baharum (2014)[6], whereby numerous IBS venture improvements in Malaysia is as yet dependent on the customary structure approach. It is suggested that IBS development life cycle procedure ought to include the selection of new business techniques, with the points of coordinating the useful controls at the beginning phases of task [7].

From previous study, stated that in design approach, IBS project still use traditional design which is not adequate and also causes barrier into this new technology. Thus, in this research there will be a new method called Hybrid System to be featured. And to be figured out whether this method can causes delay nor get it be known as a successful method.

1.1. Mixed Method of IBS and Conventional

Construction nowadays has started the new method which is mix up the conventional and Industrialized Building (IBS). In previous, at the early stage of IBS involvement in construction industry, people mostly used one hundred percent IBS component starting from ground floor column to the top of roof truss.

Mixed System is characterized by the utilization of specific components that are institutionalized and manufactured in the industrial facility while others are thrown in situ at the building locales. This includes the gathering of precast components, for example, in-filled walls, restrooms and staircases which are consolidated into the principle units at the building locales. Floors, Slabs, sections and shafts are given in situ a role as these are generally simpler and less tedious pieces of the task [8]. The Mixed System, in this investigation is considered as an amalgamation of the IBS and the Conventional Construction techniques [9].

From the previous research, Lachimpadi et.al. (2012)[9] found that the mixed method of Industrialised Building System (IBS) and conventional leads to a wastage at the second place which as follows at Table 1 below:

| Construction waste generation rates (WGR) for the 3 Construction Method (Lachimpadi et. al., 2012)[9] |
|---|---|---|---|
| Category | Project sites | Floor space (m²) | Total construction waste (tons) | Waste generation rate (tons/m² floor space) | Waste generation rate (tons/100 m² floor space) | Average | Average |
| I: Conventional Construction | Site 1 | 101297.30 | 5357.5 | 0.053 | 0.048 | 5.20 | 4.8 |
| | Site 2 | 27498.72 | 1117.1 | 0.043 | 0.044 | 4.26 | 4.2 |
| | Site 3 | 111536.00 | 3792.2 | 0.033 | 0.034 | 3.40 | 3.4 |
| II: Mixed System | Site 4 | 133308.00 | 4200.0 | 0.032 | 0.033 | 3.15 | 3.2 |
| | Site 5 | 178181.81 | 4545.4 | 0.035 | 0.036 | 3.50 | 3.5 |
| III: Industrialised Building System (IBS) | Site 6 | 116666.05 | 1730.0 | 0.014 | 0.015 | 1.48 | 1.5 |
| | Site 7 | 37594.81 | 600.0 | 0.016 | 0.017 | 1.00 | 1.0 |
| | Site 8 | 71421.85 | 1130.0 | 0.016 | 0.017 | 1.58 | 1.6 |
1.2. Hybrid System

Hybrid is a thing made by combining two different elements [10]. In this research, hybrid is a combination of the same component from IBS and conventional in-situ method. For example, beam structure has been combined between IBS precast and cast in-situ. Thus it is called a Hybrid System because of using a similar component with a two way methods to attach together. A model of Best Practice for Hybrid Concrete Construction (HCC) from United Kingdom shown in Table 2. had been created by Glass (2015)[11]. The model comprises of 8 phases beginning from briefing until construction 2. The creator additionally records down the best practice or basic achievement factors in each phase that should consider in regards to in actualizing Hybrid Concrete Construction.

Table 2 : Best Practice for Hybrid Concrete Construction (HCC) (Glass, 2015)[11]

| Construction Stage          | Best Practices for HCC                                                                 |
|-----------------------------|----------------------------------------------------------------------------------------|
| **Briefing** : Demonstrate the need | i. Information Management - Information sharing among venture partners for exhaustive Client Needs |
| **Plausibility study**: worth doing | i. Trust/building certainty : To persuaded venture partners                              |
|                            | ii. Proof – QS arranged comprehensive costing                                          |
|                            | iii. Information Management – Shared the upsides of HCC/IBS                           |
| **Conceptual Design 1** : consider the options | i. Trust/building certainty : Main Contractors and HCC/IBS suppliers and Sub-cons          |
|                            | ii. Proof – Thorough QS Analysis on Costing and Viability                               |
|                            | iii. Manufacturability and Buildability - Practicality on location                      |
|                            | iv. Trust/building certainty Transparency and ‘open book’ of points of interest of HCC/IBS |
|                            | v. Trust/building certainty : Client input being considered in Client Brief/Needs record |
| **Conceptual Design 2** : choose the options | i. Proof – Visit the comparative finished structure/ventures                            |
|                            | ii. Information Management – Strategies the suitable gadgets for venture partners to share the data. Proposed execution pointers |
|                            | iii. Manufacturability and Buildability – Establish interface enrollment as the board apparatuses of hazard the board |
|                            | iv. Buildability – Lead time venture making arrangements for cost and time the executives |
|                            | v. Trust/building certainty : Client input being considered in Client Brief/Needs record |
| **Design 1**: Work up chosen option | i. Proof – Produce part tests, model and model of HCC/IBS                               |
|                            | ii. Information Management – Generate 'Solid Frame Profile' (IBS Supply Chain Management), |
|                            | iii. Manufacturability &Buildability – Improved redundancy/form client capacity         |
|                            | iv. Buildability – Realistic resiliences between IBS makers and undertaking creators, Use Virtual Reality (VR) for dealing with the arranging of activities |
|                            | v. Information Management – Agree on the correspondence system for On Site dynamic       |
| **Design 2**: Production Information | i. Manufacturability and Buildability-Take exhortation from precaster/IBS Suppliers       |
|                            | ii. Buildability – Optimized snare time for crane nearby, Devised methodology to ensure IBS suppliers, Set not to permit ‘unapproved’ IBS suppliers to adjusted/cures IBS segments |
| **Construction 1**: Off-site Manufacture | i. Buildability – Carry out last Virtual Reality (VR) for Simulation assembling, erection and complete development process |
| **Construction 2**: On-site work | i. Information Management – As fabricated structure Survey to be shared for entire venture partners in HCC/IBS |
1.3. Issues of Integration in Supply Chain for IBS in Hybrid System Method

As per CIMP (2007)[12] and Faizul (2006)[13], IBS has just been presented in quite a while prior in 60’ that the framework vowed to fathom and improve Malaysia development industry process, however the hesitant acknowledgment of the pertinent gatherings and the difficult undertaking of setting up the mix and participation between parties included. The foundation of the IBS arrangement in the incorporation of development flexibly chains must happen and expressed that IBS fasten players need to discover coordination achievement factors in IBS venture the board to improve a nearby working relationship with them to beat the issues experienced [14].

IBS should be a procedure that necessary synchronization in configuration, assembling and development. It will concentrate on flexibly chain, arranging, venture the executives, normalization and reiteration [15]. From previous research, we know that IBS is treated as a new method or technology in construction field. Thus, there needs so much things to be considered in order to make IBS one of the most success technology in construction. This supply chain issues has been identified as one of the problems in a Hybrid System as a new method implemented.

Saifuza, Shukor, Mohammad, & Mahbub (2016)[14] stated that current development rehearses in the Malaysian development industry assume a basic job in the fruitful conveyance of activities. While challenges regularly happen in the territory of profitability, productivity, quality and the conveyance of work, the foundation of the Construction Industry Master Plan (CIMP) has prompted activities in the usage of creative methodologies through Industrialized Building System (IBS) towards supportable development condition.

From the previous research, the causes of delay in IBS construction is as follows in Table 3:

| Author | Financial & Payment Issues | Coordination Client /Contractor | Lack of Subsco n Skill | Lack of Supervision /Manager | Weak Management | Materials | Equipment And Tools | Poor Site Condition | Poor Weather | Transportation | Drawing & Design Issues |
|--------|----------------------------|-------------------------------|------------------------|------------------------------|-----------------|-----------|---------------------|---------------------|-------------|----------------|---------------------------|
| Wael et al. (2007) | x | x | x | x | x | x | x | x | x | x |
| Dayang Sabitri, S. (2009) | x | x | x | x | x |
| Mohd Rozamuddin (2010) | x | x | x | x | x |
| Aiman O. et al. (2014) | x | x | x |
| Muhammad Fakri et al (2015) | x | x | x | x |
| Sunia et al. (2013) | x | x | x | x |
| Glanerwaga et al (2013) | x | x | x | x |
| Nafid J. A. et al. (2015) | x | x | x | x |
| Mohamed Bhaktari I.M. (2012) | x | x | x | x |
| Dr. Ashraf S. and Dr. Chahian A. B. (2016) | x | x | x | x | x |

| Total | 10 | 9 | 6 | 5 | 6 | 4 | 2 | 3 | 3 | 1 | 6 |
From the summary above, the most causes of delay is because of the financial issue which we aware that in construction, the main thing we need is a financial stability. However, the issues in transportation has been less attention to research the causes of delay whereas in eleven years from 2007 to 2018, there is only one researcher had found the causes of delay for transportation which is actually one of the biggest issues in supply chain.

1.4. Design Issues in Hybrid System Method

Zidane & Anderson (2018)[16] found that the top ten of common delay factors are as follows:
(1) Design changes during development/change orders
(2) Delays in installment of contractor(s)
(3) Poor arranging and planning
(4) Poor site the board and management
(5) Incomplete or inappropriate structure
(6) Inadequate temporary worker experience/building techniques and approaches
(7) Contractor's money related troubles
(8) Sponsor/proprietor/customer's money related troubles
(9) Resources lack (HR, apparatus, gear)
(10) Poor work profitability and lack of abilities.

From the findings, issues on design changes during construction in a top rank in this study which is the top causes of delay.

As indicated by Masood et. al. (2015)[17] in his research, significant postpone classifications, in plummeting request (of criticality) are defers identified with Design, Economy/Finance, Contract, Construction Site, and Sub-contractual worker. Which the first major of delay also being identifies by design issues [17].

In a Hybrid System method, design has become an important part for the structural because the main component like beam and slab are the structure that applied this new Hybrid System method. From the report in applying for Extension of Time (EOT) from main contractor, the design changes for the Hybrid System component is one of the reason for the extended time needed to complete the projects.

2. Conclusion

In conclusion, Hybrid System is the new technology method implemented in Industrialised Building System (IBS) construction. A new method, however, need to be considered to identify the various issues that can cause delay in projects. This is because, a technology system is implemented to make the construction field easier to manoeuvre, less cost, high in quality, and fast completion in order to reduce the time taken in construction. However, from the literature review, it has be found that one of the biggest causes of delay is the financial followed by design drawing and coordination planning. In further, this new Hybrid System method will be analysed whether the new method leads to delay in Industrialised Building System (IBS) construction or inclining to minimize the causes of delay.
References

[1] Yusof, M. R., Musa, M. F., Samsudin, N. S., Mohammad, M. F., & Baharuddin, M. N. (2016). Industrialised Building System (IBS) / Off-Site Project Management Life Cycle. ISSC 2016: International Soft Science Conference, 635–642.

[2] Mohamad Kamar, K. A., & Alshawi, H. Z. (2009). Barriers To Industrialized Building System (IBS): the Case of Malaysia. Built and Human Environment 9th International Postgraduate Research Conference.

[3] Blismas, N., & Wakefield, R. (2008). Drivers, Constraints And The Future Of Offsite Manufacture In Australia Nick Blismas. 1–13.

[4] Blismas, N., Wakefield, R., & Hauser, B. (2010). Concrete Prefabricated Housing Via Advances in Systems Technologies - Development of a Technology Roadmap. Engineering, Construction and Architectural Management. https://doi.org/10.1108/09699981011011357

[5] CIDB (2009), Industrialised Building System (IBS): Implementation Strategy from R&D Perspective. Construction Industry Development Board Malaysia (CIDB), Kuala Lumpur.

[6] Nawi, M. N. M., Jalaluddin, S. M. F. W. S., Zulhumadi, F., Ibrahim, J. A., & Baharum, F. (2014). A Strategy for Improving Construction Projects Sustainability Through Value Management Approach. International Journal of Applied Engineering Research.

[7] Nasrun, M., Nawi, M., Akmar, F., Nifa, A., & Osman, W. N. (2015). Malaysian Industrialised Building System (IBS): A Review of Studies. (May).

[8] Badir, Y.F., Kadir, M.R.A. and Ali, A.A.A (1998) Theory of classification on Badir-Razali Building system classification, Bulletin of Institute of Engineer, Malaysia, October.

[9] Lachimpadi, S. K., Pereira, J. J., Taha, M. R., & Mokhtar, M. (2012). Construction Waste Minimisation Comparing Conventional and Precast Construction (Mixed System and IBS) Methods in High-Rise Buildings: A Malaysia case study. Resources, Conservation and Recycling. https://doi.org/10.1016/j.resconrec.2012.08.011

[10] Definition of Hybrid (2019). The Oxford English Dictionary. Retrieved from Oxford Dictionary online database.

[11] Glass J., (2005). A Best Practice Process Model for Hybrid Concrete Construction, Construction Management & Economics, 23(2), 169-184.

[12] CIMP (2007), Construction Industry Master Plan 2006 – 2015 (CIMP 2006 – 2015), Construction Industry Development Board Malaysia (CIDB), Kuala Lumpur.

[13] Faizul, N.A. (2006). Supply Chain Management in IBS Industry, Malaysia International IBS Exhibition, Kuala Lumpur.

[14] Saifuza, A., Shukor, A., Mohammad, M. F., & Mahhub, R. (2016). Towards Improving Integration of Supply Chain in IBS Construction Project Environment. Procedia - Social and Behavioral Sciences, 222, 36–45. https://doi.org/10.1016/j.sbspro.2016.05.172

[15] Anuar, K., Kamar, M., Hamid, Z. A., & Alshawi, M. (2010). The Critical Success Factors (CSFs) to the Implementation of Industrialised Building System (IBS) in. 10–13.

[16] Zidane, Y. J. T., & Andersen, B. (2018). The top 10 universal delay factors in construction projects. International Journal of Managing Projects in Business, 11(3), 650–672. https://doi.org/10.1108/IJMPB-05-2017-0052

[17] Masood, R., Ali, M., Shafique, F., Shafique, M. A., Zafar, B., Maqsoom, A., & Ullah, Z. (2015). Investigating the Delay Factors of Construction Projects in Metropolitan City of a Developing Country. J. Civil Eng. Architect. Res, 2(9), 947–955. Retrieved from https://www.researchgate.net/publication/281834794