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Industrialized Building System Plan of Work

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ABSTRACT

Industrialised building systems (IBS) is a term used to describe construction method that produced building components manufactured in a factory, transported and assembled into a structure using appropriate machinery and equipment with minimal workers on site. The project life cycle is a project independent series of activities that commences from the starting point until the moment it was successfully delivered. Generally in a construction project, the phases or stages are initiating, planning, executing, monitoring and controlling as well as the closing stage. This paper is part of an on-going research on the IBS project management life cycle through the IBS approach in the Malaysian construction industry. The data and information presented is the review of the available relevant literature on this research topic. This paper incorporates an analysis of the definitions and IBS/off-site plan of work or similar to it outside Malaysia. The identification of the plan/cycle from the analysis is critically essential to becoming the fundamental foundation for further research into the subject matter. It is hoped that at the end of the core research, industry players will be provided with a guideline that adopts a concept of "cradle to grave" in managing IBS throughout its plan of work/life cycle.

Keywords: Industrialized Building System, Project Life Cycle, Best Practice, Plan of Work, Industrialised Building Systems Plan of Work
JEL Classifications: L74, M11

1. INTRODUCTION

In view of meeting the government's ambition to transform the Malaysian construction industry into using the modern method of construction and to expedite the implementation of the industrialized building systems (IBS) Roadmap and Construction Industry Master Plan (CIMP) 2006-2015, there is a call for the industry players for a proper and structured planning and implementation strategy for IBS to be established.

In the year 2008, a circular from the Malaysian Treasury Department of the Ministry of Finance denotes that the policy on full utilization of IBS to be imposed for all government projects in Malaysia (Kamar et al., 2009). Construction Industry Development Board (CIDB) (2010) had launched 2nd IBS Roadmap 2011-2015 to replace the current roadmap (IBS Roadmap 2004-2010) initiated in late 2010. This strategic plan was aimed to introduce the high level intended outcomes in implementing the IBS. The new roadmap will focus more on promoting the adoption of IBS by the private sector. The four policy objectives were quality, efficiency, competency, and sustainability. Furthermore, the newly introduced Construction Industry Transformation Programme (CITP) has highlighted the importance of IBS towards enhancing the Malaysian construction industry (CITP, 2015). Hence, IBS sector contributes to the competitiveness of the construction sector and the adoption of sustainable agenda lead by the government.

With better productivity, quality and safety, IBS can help towards achieving a better construction industry, as well as enhance the global competitiveness of the Malaysia construction industry.

2. WHAT ARE PROJECT LIFE CYCLE, BEST PRACTICE AND PLAN OF WORK?

The project life cycle is an independent series of activities that start from the beginning until it was successfully delivered. Generally in a construction project, the phases or stages are initiating, planning, executing, monitoring and controlling as well as its closing stage. It is sequential and seems to be typical of a waterfall implementation concept. The four broad, generic project phases are as shown in Figure 1 (PMI, 2008).

The best practices are method or techniques that have consistently shown the expected result and being learnt to benchmarks similar exercises or task of activities. One of the aims of this approach is to maintain the quality of product and process. It can be classified as knowledge that underpins the examples of excellence and could seem like one of the management standards. There are cases of an organization that offers the "pre-made templates" to share their best practices in business.

For the plan of work, Hughes (2001) stated that plan of work is schemes that explain how best to organize the processes involved in a construction project. It has been establishing for many years that there is not one best way to arrange the works due to a tendency for various construction industry companies to produce schemes to overcome the organizational difficulties associated with running projects (Hughes, 2001; Woodward, 1965).

The authors can conclude that whether a project life cycle, a best practice or a plan of works, the main point for these three definitions is to complete the task given by using a strategic planning or process that consist several key point stages.

3. PROBLEMS AND ISSUES

According to CIMP (2007) and Faizul (2006), IBS has already been introduced in Malaysia long time ago in 60's that the system promised to solve and improve Malaysia construction industry process, but no without its issues. The grudging acceptance of the relevant parties and the challenging task of establishing the integration and cooperation between parties involved are among the issues identified.

The establishment of the IBS provision in the integration of construction supply chains must take place and stated that IBS supply chain players need to find integration success factors in IBS project management to improve a close working relationship with them to overcome the problems encountered (Abd Shukor et al., 2009). Kamar et al. (2010) mentioned that IBS need to be a process that required synchronization in design, manufacturing and construction. It will focus on supply chain, planning, project management, standardization and repetition (Kamar et al., 2010).

Traditional construction life cycle was based on the client brief; the architect produced the design followed by the structural design by the engineer. The design/drawings were then passed to the quantity surveyor to do the estimate and to generate the bill of quantities. The tender document is given to the contractors who will be bidding for the project. The contractor consults with the manufacturer and builds the structure and takes the responsibility for it. This conventional approach is known as "over the wall" syndrome (Evbuomwan and Anumba, 1998). This process only allows the manufacturers and contractors to be involved during the construction stage thus; this creates problems in the supply chain process and constructability related issues.

A study was done by Blismass and Wakefield (2008) also stated that the traditional construction process is unsuitable for offsite manufacturing (or IBS construction) and poses a substantial barrier to its adoption (Blismass and Wakefield, 2008). The finding of the study is supported by other previous studies CIDB (2009), Nawi et al. (2009) and Nawi et al. (2014), whereby many IBS project developments in Malaysia based on the traditional design approach. It is also recommended that IBS construction life cycle process should involve the adoption of new business strategies, with the aim of integrating the functional disciplines at the early stages of the project (Nawi et al., 2015).

4. IBS/OFF-SITE PROJECT LIFE CYCLE, BEST PRACTICE AND PLAN OF WORKS

4.1. Archibald's Project Life Cycle

Archibald (1976) explains the project life span as the project life cycle has identifiable start and end points, which can be associated with a time scale. A project passes through several distinct phases as it matures. The life cycle includes all parts from the point of inception to the final termination of the project as shown in Figure 2.

4.2. The Best Practice for Hybrid Concrete Construction (HCC)

In the United Kingdom, a model of Best Practice for HCC showed in Table 1 had been developed by Glass (2005). The model consists

Figure 1: Simple project life cycle model

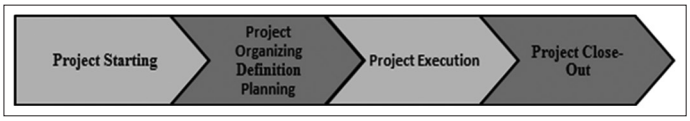
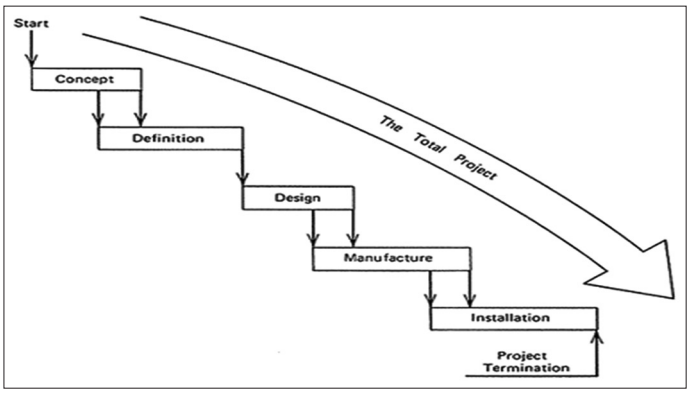


Figure 2: Archibald's project life cycle



of eight stages starting from briefing until construction. The author also lists down the best practice or critical success factors in each stage that need to be considered during the implementation of the HCC.

4.3. Integrated Project Delivery

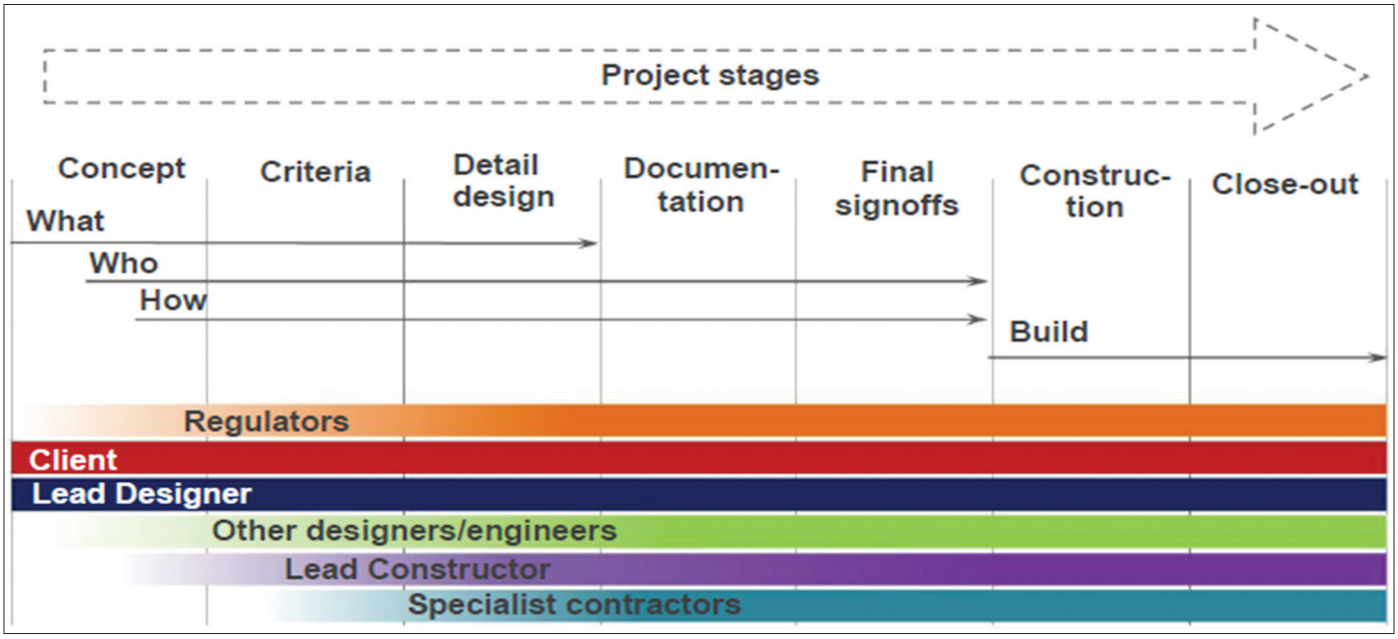
Based on Figure 3, the involvement of manufacturers in the design process during the early stage will make the collaborative work much easier in approaching the project systematically (The

Table 1: The best practice for HCC

Construction stage	Best practices for HCC
Briefing: Demonstrate the need	• Knowledge management – Information sharing among project stakeholders for comprehensive client needs
Feasibility study: Is it worth doing	• Trust/building confidence: To convinced project stakeholders • Evidence – QS prepared holistic costing • Knowledge management – Shared the advantages of HCC/IBS
Conceptual design 1: Consider the options	• Trust/building confidence – Main contractors and HCC/IBS providers and sub-cons • Evidence – Thorough QS analysis on costing and viability • Manufacturability and buildability - Practicality on site
Conceptual design 2: Choose the option	• Trust/building confidence- Transparency and "open book" of advantages of HCC/IBS. Project architect must 'champion' the promotion HCC/IBS • Evidence – Visit the similar completed building/projects • Knowledge management – Strategies the appropriate devices for project stakeholders to share the information. Proposed performance indicators • Manufacturability and buildability – Establish interface registration as management tools of risk management • Buildability – Lead time project planning for cost and time management
Design 1: Work up chosen option	• Trust/building confidence: Client feedback being considered in client brief/needs document • Evidence – Produce component samples, prototype and model of HCC/IBS • Knowledge management – Generate "Concrete Frame Profile" (IBS supply chain management), • Manufacturability and buildability – Improved repetition/mould user ability • Buildability - Realistic tolerances between IBS producers and project designers, use VR for managing the planning of projects
Design 2: Production information	• Knowledge management – Agree on the communication strategy for on site decision-making • Manufacturability and buildability- Take advice from precaster/IBS suppliers • Buildability - Optimized hook time for crane on site, Devised strategy to protect IBS providers, Set not to allow "unauthorized" IBS providers to modified/remedies IBS components
Construction 1: Off-site Manufacture	• Buildability – Carry out final VR for simulation manufacture, erection and complete construction process
Construction 2: On-site work	• Knowledge management – As built building survey to be shared for whole project stakeholders in HCC/IBS

VR: Virtual reality, HCC: Hybrid concrete construction, IBS: Industrialized building systems

Figure 3: Integrated project delivery by Mossman (2008)

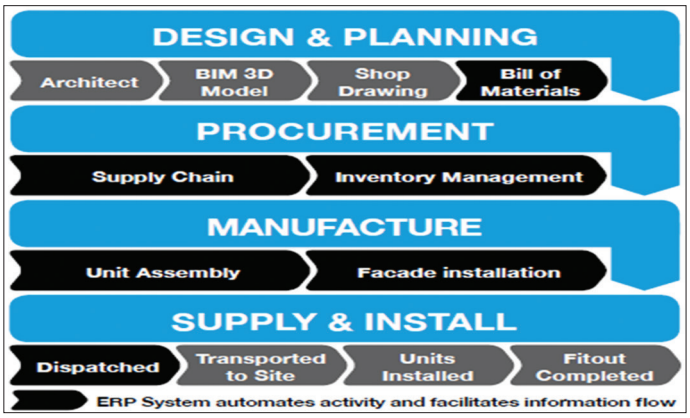


American Institute of Architect, 2007). According to Konchar (1998), the organizational integration brings better results regarding costs, time and quality. The project has automatically improved communication and prevention of potential conflicts in the workplace (Konchar, 1998). Building information modeling (BIM) and allows information into downstream processes runs smoothly by giving the preference to direct digital exchange and elimination of unwanted data. BIM also enables early and direct input on the design from the fabricators to increase fabrication and preassembly efficiencies (Khemlani, 2009).

4.4. Enterprise Resource Planning (ERP)

Hickory Building System (2014) from Australia produced a process that can be called off-site construction process based on their product (Figure 4). The process had four main phases supported by several sub-phase. The key factors in the process are the used of BIM and ERP. ERP guides each step of the project sequence by managing information flow and processes. By using the ERP software, it feeds project information and the bill of materials through to the machinery and controls key functions including supply chain, payroll, manufacturing program, inventory management and financial forecasting (Hickory Building System, 2014).

Figure 4: Enterprise resource planning



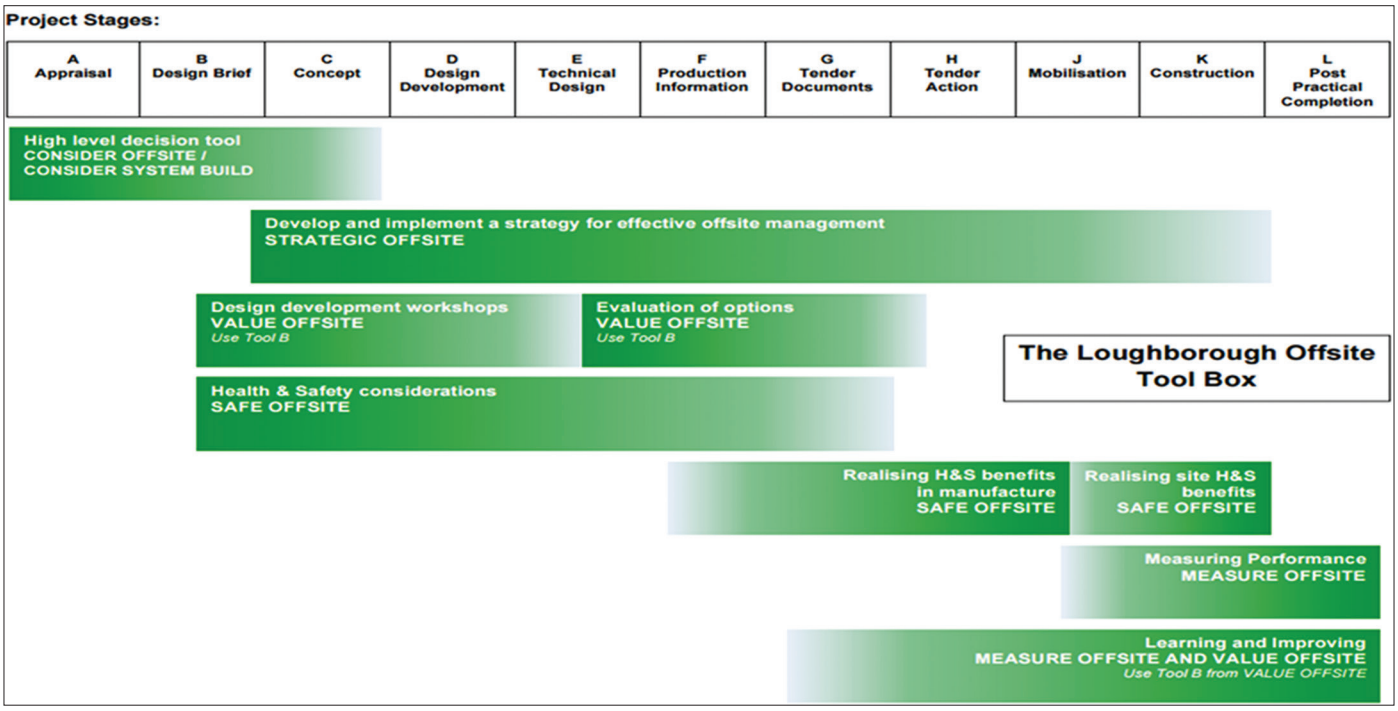
4.5. The Loughborough Offsite Tool Box

The Loughborough University (2014) had developed a process that is The Loughborough Offsite Tool Box (Figure 5) comprises a series of interactive tools to evaluate the use of offsite manufacturing, standardization and pre-assembly techniques in construction projects from the early stage of development start with appraisal until post practical completion stage. This tool box helps the user of this tool box to identify the factors need to be considered before, during and after the project.

4.6. Royal Institute of British Architects (RIBA) Plan of Works 2013

The RIBA had developed RIBA Plan of Work started in 1963 and continue to fruition in1968, 1973, 1998, 2007 and the latest one in 2013. The RIBA Plan of Work has been a bedrock document for the architects' profession and the construction industry, providing a shared framework for the organization and management of building projects that is widely used as both a process map and a management tool, and providing important work stage reference points used in a multitude of contractual and appointment documents and best practice guidance (RIBA, 2013). The RIBA Plan of Work 2007 only aligns to a single (traditional) procurement route and makes assumptions about the timing of planning applications. According to RIBA (2013), this RIBA Plan of Works developed in 2013 (Figure 6) fit for purpose for the construction industry in the 21st century to help deliver capital and operational efficiencies, carbon reductions and better briefing and outcomes. Besides that, the main benefits of this plan by giving more efficient in design processes. It is also

Figure 5: The Loughborough Offsite Tool Box



can be used by the whole project team in all size, type of project and all procurement routes.

5. RESEARCH METHODOLOGY

The methodology of the research is by literature review. The search for documentation and discussion involve an extensive review of the current and development of IBS life cycle or similar through definitions and overview of project life cycle across the sectors from other countries. The information was gathered from the secondary data comprising relevant books, journals, reports, web pages and conference proceedings. It attempts to review the definitions and the best IBS life cycle models that were produced.

6. SIGNIFICANCE OF RESEARCH

The introduction of IBS life cycle/plan of work is very much relevant to CIMP 2006-2015, IBS Roadmap 2011-2015 and currently in CITP 2016-2020. The importance of the IBS has been highlighted under the strategic thrust 1: Integrate the construction industry value chain to enhance productivity and efficiency in the CIMP 2006-2015 (CIDB, 2007). The essential element in IBS Roadmap 2011-2015 has focused on four policy objectives which are quality, efficiency, competency and sustainability on IBS implementation which is important to identify the critical factors in project life cycle to produced IBS Life Cycle based on our construction industry. Furthermore, the newly introduced CITP has highlighted the importance of IBS towards the Malaysian construction industry (CITP, 2015).

7. DISCUSSION AND FINDINGS

Based on Table 2 and literature reviews, the models of the off-site plan of work evolve start from 1076 until 21' century. The Archibald's project life cycle and RIBA plan of work version 1963 can be described the early model developed for the off-site construction industry. The 21' century models become more comprehensive by providing more stages and tasks in their plan of work to suit the rapid change in the construction sector. Besides that, 4 of 6 models above used support tool such as BIM or their own develop tool (Model No. 3-6).

The model of the life cycle/plan of work need to be developed for IBS in Malaysia must suitable with open building system, where the components can be from various manufacturers that can be used to construct a building IBS. These systems provide fair competition among manufacturer and supplier to provide good quality product with reasonable price. Besides that, the model should be supported by new technology or software such as BIM. Nowadays, BIM in Malaysia already got attention by government and industry player to implement in their project. Lastly, the stages in the plan of work also need to include critical success factors and information when the industry players need to get involve at each stage.

Figure 6: Royal Institute of British Architects Plan of Works (2013)

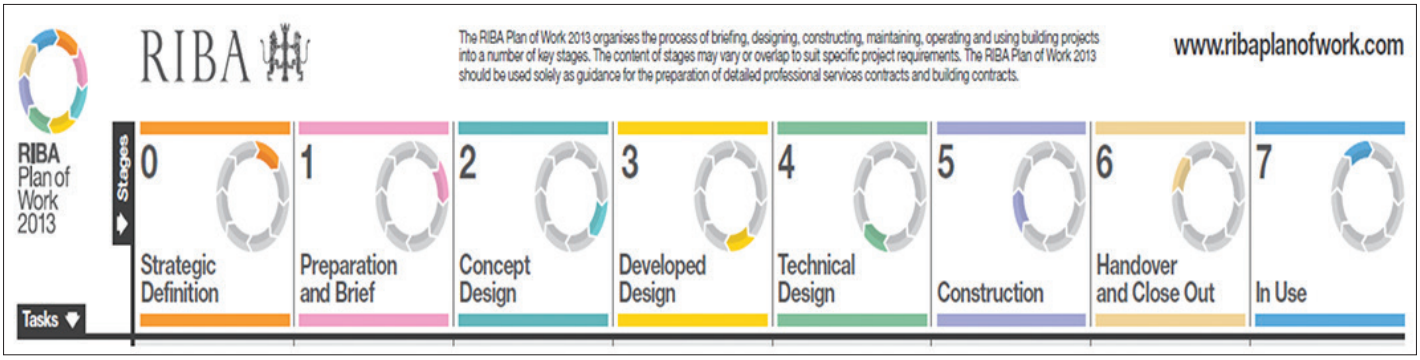


Table 2: Extract from models

Models	Findings
Model 1 - Archibald's Project Life Cycle by Archibald (1976)	Six main stages consist of concept, definition, design, manufacture, installation and project termination. This model can be say one of the earliest models of project life cycle for off-site construction
Model 2 - The Best Practice for HCC by Glass (2005)	Eight stages with every stage stated the best practices that can be implementing. The stages are briefing, feasibility study, conceptual design 1 and 2, design 1 and 2 and follow by construction 1 and 2
Model 3 - Integrated Project Delivery by Mossman (2008)	Consists of seven stages starting from concept, criteria, detail design, documentation, final signoffs, construction and finally close-out. The model supports by BIM software to smooth the process
Model 4 - ERP by Hickory Group (2014)	The ERP consist four main phases that are design and planning, procurement, manufacture and supply and install. The four main phases in ERP has also been supported by 12 sub-phases to maximize the process of construction. The ERP model supports by BIM software
Model 5 - The Loughborough Offsite Tool Box by Loughborough University (2014)	The Loughborough University has developed The Offsite Tool Box that helps construction parties to make decision making in using the off-site method. The tool had been created based on eleven stages start from appraisal until post practical completion
Model 6 - RIBA Plan of Work 2013 by RIBA (2013)	RIBA has redeveloped the plan of work 2007 in 2013 by compressing from 11 into 8 stages but not compromise the fundamental of the content. The model can be used integrated with BIM software

HCC: Hybrid concrete construction, BIM: Building information modeling, ERP: Enterprise resource planning, RIBA: Royal Institute of British Architects

8. CONCLUSION

Construction research that focuses on the IBS project management life cycle is still at an initial stage in a relatively new field, especially in developing countries as the Malaysian construction industry exemplifies. IBS is widely used, practiced and implemented in developed countries such as the USA and the UK for many years due to its benefits and advantages toward the end users in the respective countries. It suggested that more research on this scope of IBS needed to be conducted in the context of the Malaysian construction industry scenario. It is necessary to enable Malaysia to move forward from the conventional construction towards IBS, which will revolutionize the pattern and mode of the offsite construction industry.

CITP 2016-2020 is a guide for the future direction of Malaysian construction industry by the Malaysian government. The CITP is developed in supporting the Eleventh Malaysia Plan 2016-2020 and contains four strategic thrust with a total of 18 initiatives which one of them focus on IBS under productivity strategic thrust. According to Nawi et al. (2015) stated in his research, Malaysia construction industry players are using conventional method for IBS project and this will interrupt the process of delivery the project in time due to there is no reference to being followed by industry players. The Malaysia IBS needs to have their particular plan of work/life cycle to overcome this problem. This situation becomes worse when IBS in Malaysia are mainly a close system, where the components of a building are made from one manufacturer only, and this can be referred to the proprietary character.

The current study has established the definition and explored the IBS life cycle or alike from outside Malaysia. The presented literature has shown that the definition, overview and IBS life cycle or alike constitute the main challenges to the implementation of IBS in Malaysia.

The IBS life cycle or alike also can contribute to sustainability in the built environment through the suitable and improved activities suited for IBS approach in a construction project. Furthermore, Mohammad (2013) has highlighted that IBS contributed to sustainability and improved the quality of life in the built environment. The outcomes of IBS life cycle/plan of work adoption includes producing less waste (offsite and on-site), high-quality products, reducing damage towards the environment and ecosystems, less air and sound pollution, safety on-site and in the factory vastly improve and reduce site disruption.

Future studies should examine the view on the overall process, the requirements and the implementation to produce the framework of the IBS life cycle/plan of work in according to our construction industry. Finally, the current research is part of a current on-going study that the outcome will hopefully enhance the process and the application of IBS in Malaysia. The results of the core research will aim to provide the basis for a guideline to support and strengthen the Malaysian construction industry understanding and implementation of IBS project life cycle.

9. ACKNOWLEDGMENT

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