

Critical Review of Industrialised Building System in Malaysian Construction Industry

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Abstract—Industrialised Building System is a valuable construction system compare to conventional building system. Successful implementation of IBS in construction industry can offer various benefits compare to conventional in-situ systems. High speed of construction, cost savings, reduction of unskilled workers, faster and better quality control of construction are the significant advantages of IBS. This study via a comprehensive critical literature review from previous research, case studies and construction reports reviews the variety definitions of IBS. Furthermore, the advantages and disadvantages of IBS system will be discussed. This research defines IBS as a systematic process of integrated and coordinated elements enhancing the efficiency, productivity and effectiveness of the construction industry whereas mostly of the prefabricated components are manufactured preferably offsite, transported to the construction site and assembled on to the site with minimal site activities contributing to less wastage. Nowadays, to be a successful construction industry player it is a valuable alternative via utilizing IBS as a significant valuable tool to enhance the competitive advantages through achieving the international and global competitiveness, productivity, effectiveness and quality. Therefore, the findings of this research could assist the professional parties of construction industry in providing a better knowledge ground for improving decisions making to facilitate and achieve the success of IBS construction projects implementation.

Keywords—Construction Industry, IBS Roadmap, Valuable Construction System, Industrialised Building System, Prefabricated Components.

I. INTRODUCTION

Industrialised Building System (IBS) is regarded as many terminologies such as a product, process, technique, approach, system and development model. There have been many programmes and promotions by Malaysian Government in order to implement the Industrialised Building System (IBS) as an efficient and valuable construction system [1]. Even though the IBS has been used since 1966, there is not an agreed definition on Industrialised Building System (IBS) which could elaborate this construction method [2, 3]. Nevertheless, there have been a number of studies which describe the Industrialised Building System (IBS) as off-site method (manufacturing, production and construction), construction and building system (automation, non-traditional Industrialisation, innovative solutions, modularisation, prefabricated, precast and pre-assembled [1, 4-12]. Consequently, without considerations to these various definition the main objective of IBS construction implementation is to

improve the efficiency, quality, cost effectiveness, safety and health, waste reduction and effectiveness within the construction industry [1]. To achieve this objective, IBS should be viewed as altering the conventional perception, improving the capability and competency, enhancing the cooperation, trust and team working, encouraging the innovation and attaining the high integration [11, 13]. Consequently, major advantages of Industrialised Building System (IBS) implementation are: faster and cleaner construction, less labour, wastages and construction costs, site materials reduction, better quality and effective site management, improve standardization and quality improvement that ultimately will produce improved IBS within the construction industry [2, 13].

This paper consists of the main concerns on IBS which are the definitions, advantages and disadvantages. Therefore, this paper is organized into four major parts. The first part of this paper will discuss the variety definitions of Industrialised Building Systems (IBS). Secondly, a broad category of advantages and disadvantages of implementing the Industrialised Building Systems (IBS) in construction industry will be described. The third part of this study will discuss on the major efforts within the IBS construction industry and the last part of this research includes the research conclusion which is hoped to develop the construction industry opportunities for IBS utilisation as an efficient and effective construction technique to improve the productivity, quality and global competitiveness.

II. DEFINITIONS OF INDUSTRIALISED BUILDING SYSTEMS (IBS)

Industrialized Building System (IBS) is mostly recognized as prefabrication and industrialization expressions for supply chain parties, project stakeholders, practitioners, researchers and the government in the Malaysian construction industry. On the other hand, it should be noted that IBS is not obviously defined regarding to its major characteristics because it is commonly substituted as offsite and prefabrication [1, 3, 4]. Moreover, IBS definitions and concepts are based on the experience of users, perceptions and understanding, which may change in every country and region. Consequently, several studies illustrated IBS as off-site construction [OSC; 8], off-site production [OSP; 5-7], industrialized and automated construction [12], off-site manufacturing (OSM), prefabricated building, pre-assembled building and pre-assembly [1, 10]. Furthermore, IBS could be more elaborated by other definitions such as pre-cast building, pre-cast

construction, non-traditional building, industrialised building, industrialized construction, modularization, innovative building solutions and a Modern Method of Construction (MMC) [1-2, 4, 9]. Additionally, [14] asserted that Modern Method of Construction (MMC) is approved in the United Kingdom as a combined explanation for both offsite based construction tools and innovative onsite tools and technologies.

Nevertheless, without major concerns on these extensive terms, they have similar objectives which is intended to manufacture the structure components for the construction of buildings in a more control environment (desirably offsite manufacturing) instead of to build them on the construction site (onsite manufacturing). Furthermore, IBS is aimed to enhance the productivity, efficiency, quality and effectiveness of IBS construction projects [1-2].

Various definitions (twelve definitions) of IBS have been recognized in different studies as demonstrated in Table 1.

Table 1: Definitions of IBS.

Author	IBS Definition
[1]	A construction technique which components are manufactured in a controlled environment (on or off site), transported, positioned and assembled into a structure with minimal additional site works contributing to less wastage.
[4]	As prefabrication process and construction industrialization concept.
[15]	A method of construction established based on innovation and on rethinking the various techniques of construction.
[16]	Mass production of building components in factory (offsite) or at site (onsite).
[17]	A construction system that is built using pre-fabricated components.
[18, 19]	A construction method through the use of best construction machineries, equipments, materials and extensive planning of the construction projects.
[20]	An integrated manufacturing and construction process with well organization and activities management.
[21]	The process of preassembly, organization and completion of final project assembly before installation.
[22]	A set of interrelated elements that act together to enable designated performance of building which includes several procedures (managerial and technological) for the production and installation of these elements.
[23]	An industrialised system of components production or building assembly or both.
[24]	An integrated system including software and hardware which building components are planned, fabricated, transported and assembled at site.

According to Table 1, the starting definition of IBS which is by [24], indicates the IBS as a system comprising of software elements including the system design (a complex process of studying the requirement of the end user, market analysis, development of standardized components and etc.) and the hardware elements including the structural analysis. Nevertheless, the definitions in Table 1 highlighted on prefabrication, off-site production, off-site manufacturing and mass production as the major features of IBS. Furthermore, based on Table 1, seven authors have defined IBS as a

method, concept, technique, approach and process [1, 4, 15, 18-21]. On the other hand, five authors [16-17, 22-24] defined IBS as a product, system and technology. Hence, from the Table 1, most of the researchers agreed that IBS is an integration technique of construction process which consists of the manufacturing, transportation and assembly of prefabricated components. Consequently, it should be noted that without consideration to these various IBS definitions, the aim of IBS utilisation in construction projects is to alter the views of construction professional parties from the onsite construction to offsite construction (desirably off site manufacturing) as a more controlled environment [1]. Therefore recently, [4] in their research, suggested that the new definition on IBS should consist of the process and system point of view along with six significant characteristics which are industrialized in transportation, production and assembly technique, mass-production, onsite fabrication, standardization and structured planning and process integration.

As a result, comparing with other twelve definitions of IBS, this research defines IBS as a systematic process of integrated and coordinated elements enhancing the efficiency, productivity and effectiveness of the construction industry whereas mostly of the prefabricated components are manufactured preferably offsite, transported to the construction site and assembled on to the site with minimal site activities contributing to less wastage. The following part of this research will discuss of the wide categories of advantages and disadvantages of Industrialised Building Systems (IBS).

III. ADVANTAGES AND DISADVANTAGES OF IBS

According to IBS Roadmap Review report, [25] the adoption of IBS in Malaysia is a client driven. Hence, client with a good knowledge and awareness of IBS benefits will be more encouraged to adapt IBS such as through assigning the designers to design their construction according to IBS. However, lack of awareness program to understand client needs and giving correct information on IBS has contributing to a lack of interest from the client and decision makers [17]. Furthermore, IBS has been introduced as a method with better productivity, quality and Safety [4].

IBS has been identified as a potential method to improve overall construction performance in terms of quality, cost effectiveness, health and safety, productivity and waste reduction [26]. Nevertheless, the large numbers of building contractors are reluctant to apply IBS in their construction projects due to cost factor, lack of previous experience, increase in project risk and lack of professional trained in IBS systems. Furthermore, in the Malaysian context, the government's policy on housing is that, the traditional building practices must be replaced by Industrialised Building System (IBS), which could save on labour, cost and time of construction while as, it could award quality and durability for building life as well as developing a better safety and security system and more cost effectiveness of IBS construction methods [27]. Adopting the usage of Industry Building Systems in the

construction of the low cost high-rise apartments had significantly giving advantages in various aspects such as reducing the construction cost, speed of construction, environmentally friendly, improved site safety and better quality construction [28]. Additionally, according to [29], IBS offers improved cash flow to developers as they could claim the costs from purchasers early as two weeks upon erection of building panels.

The advantages and disadvantages of IBS can be also compared and justified with the conventional system, whereas, conventional construction methods that have proven to be more time consuming, wasteful, difficult, dangerous and messy are illustrated in Table 2 and Table 3. The numerous advantages of IBS includes quality of products, reduce construction material wastages, fewer site workers, increase safety, faster completion time and also reducing total construction costs. Relatively, the low labor cost in Malaysia is the main root cause of the construction industry failing to reform and being complacent with the current systems of IBS, which if implemented will eventually enhance the level of productivity, efficiency, quality and safety [25; IBS Roadmap Review].

Table 2: Advantages of Industrialised Building Systems.

Advantages of IBS	Authors
Achieving High Quality	[4, 26, 27-28, 30-34]
Faster Construction Time	[28-31, 33, 35]
High Cost Saving	[26-28-31, 35-37]
Reduction of Unskilled Workers and Fewer Site Workers	[12, 29, 31]
Enhancing the Social Benefits	[12, 29, 31, 38]
Increasing the Safety	[4, 26-28, 31, 39]
Enhancing the Flexibility in Construction Projects	[12, 40]
Increasing Environmental and Construction Site Cleanliness	[28, 35-36]
Enhancing the Efficiency of Construction Projects	[4, 26, 33]
Optimizing the Site Work and Site Location	[31]

According to Table 2 the most five significant advantages of IBS which has been identified are: achieving high quality, faster construction time, high cost saving, increasing the safety and enhancing the social benefits [4, 12, 28-32, 33-37, 38-39].

Table 3: Disadvantages of Industrialised Building Systems.

Disadvantages of IBS	Authors
IBS Requires an Initial Immense Investment Cost	[12-13, 17, 32, 39, 41-43]
Prefabrication Elements are Considered Inflexible	[12, 44]
Negative Impact on Social Perception	[16]
The Industry is Uncompetitive Due to Lack of Open Collaboration	[12, 29, 31]
Requires Highly Skilled Workers	[5-6, 13, 43]
IBS is Unattractive Choice	[32]
Lack of Information in IBS Implementation	[5-6, 12-13, 16-17, 34, 45-46]
It will Cause to Transportation Related Limitations:	[44]

Lack of Contractor Expertise and Competence Manufacturer:	[44]
Investment in IBS Construction Projects are More Risky	[12, 17]

Moreover, the significant five disadvantages of IBS based on Table 3 have been stated by [12-13, 16-17, 31, 34, 39, 41-44, 46] are : IBS requires an initial immense investment cost, prefabrication elements are considered inflexible, negative impact on social perception, the industry is uncompetitive due to lack of open collaboration and lack of information in IBS implementation. However, to be competitive at the international level and in addition to become globalized, it is important for the Malaysia construction industry to evolve, be well organized and prepared such as by putting greater efforts in introducing and implementing the new IBS roadmap 2011-2015 (Second IBS Roadmap). This aim will be facilitated and successfully achieved through enhancing the productivity, efficiency, quality and safety via the IBS implementation within the construction industry. Next part of this research will have a major overview of the significant efforts within the IBS construction industry.

IV. DISCUSSION

IBS as an efficient and effective method of construction with many advantages has not yet been well implemented within the Malaysia construction industry. Even though, major endeavours and activities proposed by the Malaysian government and CIDB for successful implementation of IBS such as the development of IBS Roadmap 2003-2010 (First IBS Roadmap) as a substantial efficient and effective alternative for construction industry on the latest 2010 did not attain the objectives of this roadmap. From the 5 measurable KPI's merely one KPI (Monetary) was achieved. Additionally, the KPI's was classified into Manpower, Monetary, Materials, Bumiputera enlargement of IBS Manufacturers and IBS contractors or Installers [1, 2]. Therefore, the new IBS Roadmap 2011-2015 (Second IBS Roadmap) was established via CIDB with considering the views of construction industry professional to be as a blueprint for IBS construction industry. It should be notified that Construction Industry Development Board (CIDB, 2011) have highlighted on the four significant objectives including quality, efficiency, competency and sustainability contributing to develop and improve the sustainability within the IBS construction industry which will ultimately result to the competitiveness of Malaysian construction industry. On the other hand, the main objectives of IBS Roadmap 2011-2015 were [1, 2, 47]:

1. To sustain the existing momentum of 70% IBS content for public sector building projects through to 2015 which is not fully achieved at the latest 2012; and
2. To increase the existing IBS content to 50% for private sector building projects by 2015 which is a long way forward.

The Following part of this research will bring down brief overall concluded points of this research.

V. CONCLUSION

This research defines IBS as a systematic process of integrated and coordinated elements enhancing the efficiency, productivity and effectiveness of the construction industry whereas mostly of the prefabricated components are manufactured preferably offsite, transported to the construction site and assembled on to the site with minimal site activities contributing to less wastage. Furthermore, this study proposed and discussed the IBS variety of definitions, advantages and disadvantages. Successful and effective implementation of IBS in Malaysia construction industry can offer various benefits compare to conventional in-situ systems. Those are: the speed of construction, less wastage of materials which means cost savings, reduction of unskilled workers, faster and better quality control of construction, increased site cleanliness and safety to construction projects. These are very important aspects in achieving the efficient and effective construction industry which will enhance the market share of construction industry, enhancing the competitive advantages, preparing the construction industry for Internationalisation and Globalisation as well as contributing to the Malaysian economy.

The government of Malaysia has done a lot of efforts to enhance the current conventional, labor-intensive activities to a more technologically advanced method of construction such as by developing the Industrialised Building Systems (IBS) through the Construction Industry Development Board (CIDB). Finally, the study presented in this paper is a preliminary survey and is a part of an ongoing research, which will eventually attempt to further enhance the practices and implementation of successful IBS implementation along with introducing the collaborative technologies in construction industry, particularly in the IBS project delivery in Malaysia. Additionally, it is hoped that the results of the main research will hopefully provide and form the basis of a valuable coordination with in the IBS construction supply chain and project stakeholders in order to support the Malaysian Construction Industry Master Plan and the IBS 2011-2015 Roadmap along with strengthen the value chain in the Malaysian construction industry. Therefore, IBS should present a transparent perception and understanding for the professional parties involved within the construction industry as well as the governments and policy makers.

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