Construction Industry Experience of Industralised Building System in Malaysia

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Abstract

Government of Malaysia has done various efforts to promote the usage of Industrialised Building System (IBS) as an efficient and effective construction system compare to conventional building system. This paper reviews the experiences of Malaysian construction industry in the adoption of IBS from the first level of establishment until its development. This research select IBS as a construction technique in which components are manufactured in a controlled environment (on or off site), transported, positioned and assembled into a structure with minimal additional site works. IBS have been categorised to: precast concrete framing, steel formwork system, steel framing systems, block work system and prefabricated timber framing system. A comprehensive review from various sources conducted to define and classified IBS in this paper. The findings of this research illustrated the timeline of IBS establishment and development in Malaysia.

Keywords: Malaysia, IBS Roadmap, Effective Construction System, Industrialised Building System, Precast Concrete Framing.

1. INTRODUCTION

Industrialised Building System (IBS) can be viewed as a system, method of development, process, product, approach, technique or industrial philosophy. Government of Malaysia has done a lot of effort to promote the usage of Industrialised Building System (IBS) as an alternative construction method. Since the first project of IBS in year 1966, there has not been one absolute definition on Industrialised Building System (IBS) that could describe the entire building construction system. However, there are several definitions by researchers who studied into building construction emphasizing on the concept on off-site construction (OSC) [1], off-site production (OSP) [2, 3 and 4], industrialized and automated construction [5], off-site manufacturing (OSM), prefabricated building, pre-assembled building and pre-assembly [6]. Furthermore, IBS could be more elaborated by other definitions such as pre-cast building, pre-cast construction, non-traditional building, industralised building, modularization, innovative building solutions and a Modern Method of Construction (MMC) [7 and 8]. However, regardless of all these definitions and ideas on IBS, to enhance the productivity, efficiency and effectiveness of IBS construction projects, the main strategy and significant effort is to move most of the activities from construction site to a more controlled environment in manufacturing site (desirably off site).

Industrialised Building System (IBS) is not a new approach to the construction industry because it has just again become feasible and visible in Malaysia as a valuable solution to improve the construction industry mainly in terms of efficiency, productivity and effectiveness. In a larger view and open minded perception, IBS is further than implementing the construction project through prefabricated methods. IBS is about the changing of conventional mindset, enhancing the capability, competency and value of human capital, developing better cooperation, team working and trust among the parties in construction industry, promoting intelligibility, innovation, transparency and most significantly the high integrity that will eventually enhance the productivity and efficiency within the construction industry [9]. Moreover, IBS has been identified as a potential method to improve overall construction performance in Malaysia in terms of quality, cost effectiveness, safety and health, waste reduction, efficiency and productivity. IBS can be an approach or process implemented within the construction industry resulting in less labor-oriented, faster, satisfying the quality concern, changing of conventional mindset, reengineering of human capital development, developing better cooperation and trust, promoting transparency and integrity [10].

There are many benefits of Industrialised Building System (IBS) as a modern method of construction such as reduction in construction time, less site materials, better site management, minimal wastage, cleaner and neater environment, controlled quality, reduction of labour intensity, construction standardization, quality improvement and lower total construction costs that will eventually produce better products for the parties such as clients and contractors in construction industry [9]. It should be noted that the Malaysian government have implemented a lot of significant efforts to bringing the IBS for all professionals involved in the construction industry. One of these significant efforts is the establishment of IBS Roadmap 2003 -2010 that has been endorsed by the Government to be the blueprint document for the industrialisation of the Malaysian construction sector. Nevertheless, the effort to promote the usage of IBS as a valuable alternative compare to conventional and labour intensive construction method should be more emphasized by the CIDB of Malaysia. Consequently, successful IBS projects are Sekisui Home (Japan), Living Solution (United Kingdom), Open House (Sweden) and Wenswonen (Netherlands) [11].

This paper includes the fundamental issues on IBS which are the timeline, definitions and classification. Consequently, this paper is structured into four broad parts. Firstly, the paper will discuss the definitions of industralised building systems (IBS). Second part of this research will set up the establishment and development of IBS timeline in Malaysia. Thirdly, this research will explore on the classification system of IBS. The final part of this research will bring up the research conclusion which is developed in order to enhance the opportunities of construction industry for implementing the IBS as a valuable alternative to enhance the productivity, efficiency, effectiveness and quality in order to be organized for internationalization and global competitiveness.

2. DEFINITIONS OF INDUSTRALISED BUILDING SYSTEMS (IBS)

IBS is usually being acknowledged as the term which represents the prefabrication concept in the perception of professional parties with in the Malaysian construction industry while as, various definitions have been offered to IBS by many researchers which this research will effort on categorizing these definitions.

Industrialized Building System (IBS) had become a term to represent prefabrication and industrialization terminologies in the Malaysian construction industry. The term of IBS is widely used by the supply chain parties and project stakeholders within the construction industry, practitioners, researchers and the government in Malaysia to signify industrialization in construction [6]. However, IBS is ill defined, due that it is often interchangeably with other terms such as offsite and prefabrication [7]. Consequently, their definitions depend greatly on user's experience, perceptions and understanding, which may differ from one country to other country. Nevertheless, it should be noted that lack of a uniform definition and uncertainty in the context along with boundary of IBS could contribute to the prejudices and misunderstanding resulting to decrease the efficiency, productivity and effectiveness of IBS implementation within the construction industry.

Regardless of IBS broad terms that particularly mentioned in the first part of this research (Introduction), they have similar objectives which is intended to move most of the activities from construction site to the manufacturing site along with manufacturing the structure components for the construction of buildings in a more control environment (preferably offsite manufacturing) rather than construct it on site (onsite manufacturing). Consequently, IBS is aimed to enhance the productivity, efficiency and effectiveness of IBS construction projects. Different definitions (eleven definitions) of IBS have been established by many researchers as illustrated in Table 1.

Table 1- Variety of IBS definitions

Author	IBS Definition
[7]	Industrialized Building System (IBS) is the term to represent the prefabrication and construction industrialization concept in Malaysia.
[12]	IBS as a construction process and an approach on manufactured components off or on site.
[13]	IBS as an organizational process-continuity of production implying a steady flow of demand, standardization, integration of the whole production process, a high degree of organization of work and mechanization to replace human labor.
[14]	Prefabricated construction that involves concrete forming, placing, finishing and curing operations away from the project site and then erecting the prefabricated components as part of a completed structure.

[15]	A construction system that is built using pre-fabricated components. The manufacturing of the components is systematically done via machine, formworks and other forms of mechanical equipment.
[16]	A construction technique in which components are manufactured in a controlled environment (on or off site), transported, positioned and assembled into a structure with minimal additional site works
[10]	IBS can be interpreted as an approach or process used in making construction less labor-oriented and faster as well as fulfilling quality concern.
[17]	A concept of mass production of quality building by using new building systems and factory produced building components.
[5]	A set of interrelated elements that act together to enable the designated performance of the building.
[18]	Total integration of all subsystem and components into overall process fully utilizing industrialized production, transportation and assembly technique.
[19]	A process, by which components of a building are conceived, planned and fabricated, transported and erected at site. The system includes a balanced combination between software and hardware component.

Based on Table 1, all the definitions emphasizes on prefabrication, off-site production, off-site manufacturing and mass production of building components as the main characteristic of IBS. Furthermore, based on Table 1, eight authors have defined IBS as a method, concept, approach and process. On the other hand, two authors [15, 17] defined IBS as a product, system and technology. Consequently only one author [19] has indicated IBS as a system and also as a process. Therefore, from the Table 1, most of the researchers agreed that IBS is an integration approach within the construction process which mostly includes the production of prefabricated components, transportation of components and at last project site erection (assembly) techniques. However, it should be emphasised that regardless of these variety of terms, the purpose of implementing IBS in construction projects is to ground more effort in changing the perception of professional construction parties form the construction site to a controlled environment of the manufacturing.

As a result, comparing with other eleven definitions of IBS, this research selects the valuable definition of IBS according to [16] as a construction technique in which components are manufactured in a controlled environment (on or off site), transported, positioned and assembled into a structure with minimal additional site works The following part of this research includes the establishment and development of a comprehensive timeline on IBS in Malaysia since the early 1960's.

3. ESTABLISHMENT AND DEVELOPMENT OF IBS IN MALAYSIA

IBS in Malaysia has been introduced and implemented in construction industry in order to deal with a growing demand of affordable housing, solving issues associated with foreign workers and improving quality, efficiency, effectiveness and productivity of construction projects. Nowadays, IBS has evolved and implemented in hybrid construction projects to build national landmark as significant valuable national assets. From the comprehensive literature review, establishment and development of IBS have been illustrated through the timeline as shown in Figure 1.

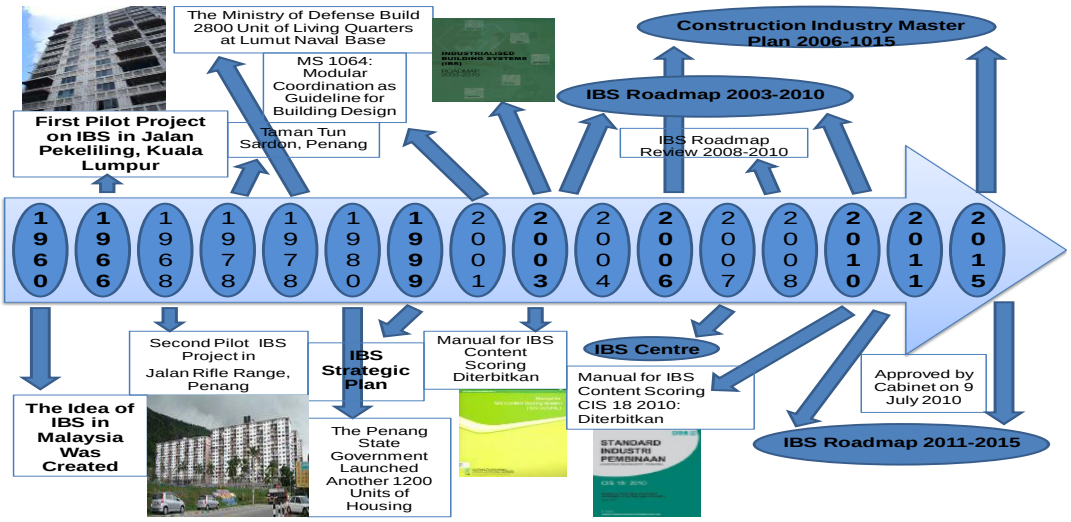

Figure 1. Establishment and development of IBS in Malaysia

As shown in Figure 1, various efforts have been adopted since the establishment of IBS in Malaysia on the early 1960's. Furthermore, these efforts have been reviewed and improved for enhancing the efficiency, effectiveness and successful implementation of IBS until 2015. These various efforts as illustrated on Figure 1 will be briefly discussed on this part.

The usage of IBS in Malaysia has begun since early 1960's in a low cost housing scheme when Ministry of Housing and Local Government of Malaysia visited several European countries and evaluate their housing development program [20]. After their visit in 1964, the government had launched first pilot project on IBS to speed up the delivery time and built affordable and quality houses. Almost, 22.7 acres of land along Jalan Pekeliling, Kuala Lumpur was dedicated to the project comprising of seven blocks with 17-storey flats (3,000 units of low-cost flat and 40 shops lot). This project was awarded to JV Gammon & Larsen and Nielsen using Danish System of large panel pre-cast concrete wall and plank slabs. Consequently, the project was completed within 27 months from 1966 to 1968 including the time engaged with the construction of the RM 2.5 million casting yard at Jalan Damansara [16, 20, 21 and 22]. Moreover, in 1968, the government of Malaysia launched a second housing project which was a six block of 17-storey flats and three blocks of 18-storey flats at Jalan Rifle Range, Penang. The project was awarded to Hochtief/ Chee Seng using French Estoit System [16, 21, 22 and 23].

Precast concrete is one of the main IBS category built in Malaysia since 1960s. Nevertheless, these buildings were normally associated with pre-fabricated mass construction method, low quality buildings, leakages, abandoned projects, unpleasant architectural appearances and other drawbacks. Furthermore, due to the poor architectural design, the old pre-fabricated buildings have given the public, bad impression about precast concrete. While as, there have been quite a number of cases where the use of IBS had lead to such drawbacks such as, in the case of Pekeliling Flats in Kuala Lumpur and Taman Tun Sardon, Gelugor, Penang. In the case of Taman Tun Sardon the design was very basic and not considering the aspect of serviceability such as the need for wet toilets and bathrooms [16].

In 1978, the Penang state government launched another 1200 units of housing using prefabrication technology. Two years later, the Ministry of Defense adopted large prefabricated panel construction system to build 2800 unit of living quarters at Lumut Naval Base [24]. In the period of 1980 till 1994 there is a huge gap of decreasing the IBS utilization towards developing and implementing the IBS. This could be because of problems in the leakage of IBS design that eventually contributing to poor image of IBS buildings for construction industry. Consequently, IBS was not popular in 1980 to 1994. Therefore, between the 80's and 90's the use of structural steel components turned particularly in high rise buildings in Kuala Lumpur. The usage of steel structure gained much attention with the construction of 36-storey Dayabumi complex that was completed in 1984 by Takenaka Corporation of Japan [16, 21 and 22].

IBS become more popular in 1990's when many Malaysian infrastructure and mega projects were build especially for the Commonwealth Games in 1998. As a result, in the booming period of Malaysian construction industry during 1994-1997, pre-cast, steel frame and other IBS were used as hybrid construction method to build national landmarks such as Bukit Jalil Sport Complex, Kuala Lumpur Convention Centre, KL Sentral Station, KL Tower, Kuala Lumpur International Airport, Lightweight Railway Train (LRT) and Petronas Twin Towers [21 and 22].

According to Construction Industry Development Board (CIDB) [25], based on the resolution which was made during the Colloquium of Industrialised Construction System in 1998, the CIDB eventually formed the IBS Steering Committee on 1999 for the effort to bring to the forefront all the IBS related issues in a framework to promote the greater usage of IBS in the construction industry and to drive the industry forward. The IBS Strategic Plan in 1999 was published as a result for establishment of this committee. Furthermore, the Construction Industry Master Plan 2006-2015 (CIMP 2006-2015) has been published in December 2006 as means to chart the future direction of the Malaysian Construction Industry. The importance and effort to promote IBS is highlighted under Strategic Thrust 5: Innovate through R&D to adopt new construction methods such as IBS in the Construction Industry Master Plan 2006-2015 [26 and 27].

These various significant efforts by the government to promote the usage of IBS as a significant alternative compare to the conventional method did not made considerable progress. Therefore, the IBS Roadmap 2003-2010 was developed and published to steer the direction of IBS implementation and promotion activities, guide the practitioners and policy makers on IBS related issues in ensuring the global competitiveness of Malaysian construction players through the efficient and effective usage of IBS. It should be noted that the formulated roadmap is a comprehensive document that divided the IBS programme into a 5-M strategy (five main focus areas) that reflects the inputs needed to drive the programme which are Manpower, Materials, Management, Monetary and Marketing [16].

IBS Roadmap 2003-2010 (First IBS Roadmap) as a significant valuable alternative for construction industry on the end of year 2010 did not achieve the goals of this roadmap. According to CIDB in Malaysia, only one KPI (Monetary) out of the 5 measurable KPI's (key performance indicators) was achieved. The KPI's was categorized to Manpower, Monetary, Materials, Bumiputera Manufacturers Development and Contractors or Installers Bumiputera Development. Hence, the new IBS Roadmap 2011-2015 (Second IBS Roadmap) is developed by CIDB under consultation with the industry players to chart the way forward for IBS industry. Alternatively, Construction Industry Development Board (CIDB) have emphasized on four policy objectives which were quality, efficiency, competency and sustainability leading to a sustainable IBS industry that will eventually contribute to the competitiveness of construction industry in Malaysia [28 and 29]. The next part of this research will briefly discuss on the classification of Industralised Building Systems (IBS).

4. CLASSIFICATION OF IBS SYSTEM

In Malaysia, Construction Industry Development Board (CIDB, 2003) has classified the Industralised Building System (IBS) system into five categories which are: pre-cast concrete framing, steel formwork system, steel framing systems, block work system and prefabricated timber framing system. Consequently, this research has classified Industralised Building System (IBS) with its sub system categories with a brief description based on Table 2.

Table 2- Classification of Industrialized Building Systems (IBS)

Type of IBS	Sub System Categories	Brief Descriptions
Precast Concrete Systems	Precast Concrete Framing, Panel and Box Systems	Comprises of precast columns, beams, slabs, 3D components (balconies, staircases, toilets, lift chambers), permanent concrete formwork and etc.
	Precast Concrete Wall System	A structural framework of the building composed of pre-cast slab and load bearing wall. The load bearing walls and slabs are manufactured off-site and transferred at site to be erected.
	Reinforced Concrete Building with Precast Concrete Slab	A combination of frames with precast concrete hollow core slab or precast planks.
Block Work Systems	Block Work Components	Contains of interlocking Concrete Masonry Units (CMU), lightweight concrete blocks and etc.
Prefabricated Timber Framing Systems	Prefabricated Timber Components	Includes timber frames, roof trusses and etc.

Formwork Systems	Formwork Components (Steel, Plastic and Aluminum)	Consists of tunnel forms, beams and columns moulding forms, permanent steel formworks, metal decks and etc.
Steel Framed Building Systems	Steel Framed Components	Comprises of steel beams and columns, portal frames, roof trusses and etc.

Table 2, shows that the precast concrete framed system which is fabricated or manufactured offsite using machine and formwork is one of the most popular forms of industrialized building system particularly in Malaysia which offers advantages such as high degree of flexibility in term of larger clear distance between columns which as a result the longer span give bigger open space and greater freedom of designing the floor areas. Following part of this research will bring down briefly the overall concluded points of this research.

4. CONCLUSION

This research select the valuable definition of IBS as a construction technique in which components are manufactured in a controlled environment (on or off site), transported, positioned and assembled into a structure with minimal additional site works. Furthermore, this study proposed and discussed the IBS timeline in Malaysia since its establishment on early 1960s along with its development towards various efforts until 2015. 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 aspect 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 Intenationalisation and Globalisation as well as contributing to the Malaysian economy.

The government 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). The government had efforts in developing the 1st and 2nd IBS Roadmap to put Malaysia construction industry in producing fast, cost effective, high quality construction products and able to compete with the global construction market. 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 Malaysian construction industry.

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6. REFERENCES

1. Pan, W., Gibb, A. and Dainty, A. R. J. (2008), "Perspectives of UK Housebuilders on the Use of Offsite Modern Method of Construction," Construction Management and Economic, **25** (2), pp. 183-194.
2. Blismas, N. and Wakefield, R. (2009), "Drivers, Constraints and the Future of Offsite Manufacture in Australia," Construction Innovation: Information, Process, Management, **9** (1), pp. 72-83.
3. Blismas, N. and Wakefield, R. (2008), "Offsite Manufacture in Australia – Barriers and Opportunities," Proceedings of the Cooperative Research Centre (CRC) for Construction Innovation Third International Conference, Clients Driving Innovation: Benefiting from Innovation, Gold Coast, Australia.
4. Blismas, N., Pasquire, C. and Gibb, A. (2006), "Benefits Evaluation for Off-site Production in Construction" Construction Management and Economics, **24**, pp. 121-130.

5. Warszawski, A., E. D. (1999), "*Industrialized and Automated Building Systems: A Managerial Approach,*" E and F N Spoon.

6. Gibb, A. G. F. and Isack, F. (2003), "Re-engineering Through Pre-Assembly: Client Expectations and Drivers" Building Research and Information, **31** (2), pp. 146-60.

7. Kamar, K. A. M., Hamid, Z. A., Azman, M. N. A. and Ahmad, M. S. S. (2011), "Industrialized Building System (IBS): Revisiting Issues of Definition and Classification," Int. J. Emerg. Sci., **1** (2), pp. 120-132.

8. Goodier, C. And Gibb, A. (2007), "Future Opportunities for Off-Site in the UK," Journal of Construction Management and Economic, **25** (6), pp. 585-595.

9. Kamar, K. A. M., Alshawi, M. and Hamid, Z. (2009), "Barriers to Industrialized Building System (IBS): The Case of Malaysia," Paper Proceedings in BuHu 9th International Postgraduate Research Conference (IPGRC), Salford, United Kingdom.

10. Shaari, S. N. and Ismail, E. (2003), "*Promoting the Usage of Industrialized Building System (IBS) and Modular Coordination (MC) in Malaysia,"* Construction Industry in Engineers (Board of Engineer Malaysia).

11. Oostra, M. and Joonson, C. C. (2007), "*Best Practices: Lesson Learned on Building Concept (edited by) Kazi, A. S., Hannus, M., Boudjabeur, S. and Malone, A. (2007),"* 'Open Building Manufacturing – Core Concept and Industrial Requirement', Manubuild Consortium and VTT Finland Publication, Finland.

12. Abd Shukor, A. S., Mohammad, M. F. and Mahbub, R. (2011), "*Supply Chain Integration Challenges in Project Procurement in Malaysia: IBS Contractors Perspective,"* Management and Innovation for a Sustainable Built Environment, 20 – 23 June, Amsterdam, Netherlands.

13. Hassim, S., Jaafar, M. S. and Sazalli, S. A. A. H. (2009), "The Contractor Perception Towers Industrialized Building System Risk in Construction Projects in Malaysia," American Journal of Applied Sciences, **6** (5), pp. 937-942.

14. Abdallah, A. (2007), "Managerial and Economic Optimisation for Prefabricetd Building Systems," Technological and Economic Development of Economy, **13** (1), pp. 83-91.

15. Rahman, A. B. A., and Omar, W. (2006), "Issues and Challenge in the Implementation of IBS in Malaysia," Proceeding of the 6th Asia Pacific Structural Engineering and Construction Conference (ASPEC 2006), Kuala Lumpur, Malaysia.

16. CIDB. (2003), "*Industralised Building Systems (IBS) Roadmap 2003-2010,"* Construction Industry Development Board (CIDB), Kuala Lumpur, Malaysia.

17. Badir, Y. F., Kadir, M. R. A. and Hashim, A. H. (2002), "Industrialised Building Systems Construction in Malaysia," Journal of Architectural Engineering, **8** (1), pp. 19-23.

18. Dietz, A. G. H. (1971), "*As Stated in Jaafar, S., et al. (2003), Global Trends in Research, Development and Construction,"* Proceeding of The International Conference on Industrilised Building System (IBS 2003), CIDB.

19. Junid, S. (1986), "*Industrilised Building System,"* Proceeding of UNESCO/FEISEAP, Regional Workshop.

20. Thanoon, W. A. M., Peng, L. W., Abdul Kadir, M.R., Jaafar, M.S. and Salit, M.S. (2003), "The Essential Characteristics of Industrialised Building System," International Conference on Industrialised Building Systems, Kuala Lumpur, pp. 283-294.

21. CIDB. (2006), "*Industrialised Building Systems in Malaysia,"* Construction Industry Development Board (CIDB), Kuala Lumpur, Malaysia.

22. CIDB. (2006), "*IBS Survey 2005: Survey on Malaysian Architects Experience in IBS Construction,"* Construction Industry Development Board (CIDB), Kuala Lumpur, Malaysia.

23. Din, H. (1984), "Industrialised Building and Its Application in Malaysia," Proceeding of Prefabrication Building Construction Seminar, Kuala Lumpur, Malaysia.

24. Trikha, D. N., and Ali, A. A. A. (2004), "*Industrialized Building System (First ed.),"* Universiti Putra Malaysia Press, Kuala Lumpur.

Fathi, M. S., Abedi, M. & Mirasa, A. K. (2012). Construction Industry Experience of Industralised Building System in Malaysia . 9th International Congress on Civil Engineering (9ICCE) 2012, Isfahan University of Technology (IUT), Isfahan, Iran, May 8-10, 2012

25.CIDB. (2005), "*Modular Construction in Construction Industry; IBS Digest,"* Construction Industry Development Board (CIDB), Kuala Lumpur, Malaysia.

26.CIDB. (2007), "*Construction Industry Master Plan (CIMP 2006- 2010),"* Construction Industry Development Board (CIDB), Kuala Lumpur, Malaysia.

27.CIDB. (2007), "*IBS Roadmap Review (Final Report),"* IBS Centre, Construction Industry Development Board (CIDB), Kuala Lumpur, Malaysia, (unpublished).

28.CIDB. (2011), "*IBS Roadmap (2011-2015),"* http://www.ibscentre.com.my/ibsweb/index.php?option=com_content&view=article&id=48&Itemid=106&lang=en [Accessed 30 October 2011].

29.CIDB. (2011), "*Transformation of Construction Industry through Industrialized Building System (IBS) Roadmap (2011-2015),"* http://www.pam.org.my/Library/notes/ibs_roadmap_2011-2015_-_PAM_21122010.pdf [Accessed 30 October 2011].