The Critical Success Factors (CSFs) to the Implementation of Industrialised Building System (IBS) in Malaysia

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Abstract

The Malaysian construction industry plays an important role in generating wealth to the country and development of social and economic infrastructures and buildings. To cope with an influx of foreign labour work in construction sector and to improve overall performance of the industry, the Malaysian construction industry has been urged to use Industrialised Building System (IBS) in building works. IBS is a construction process either by mechanising work on site or transferring the work as much as possible to the factory. This paper identifies the Critical Success Factors (CSFs) to the implementation of IBS in Malaysia. The potential CSFs to IBS are first identified through a literature search. A case study survey has being used to check the potential CSFs in real construction setting in Malaysia. The paper highlights the importance of pre-planning, coordination, effective communication, involvement in design, experienced staff, decision making, improve in procurement and contract, supply chain management, partnering, business strategy and Information and Communication Technology (ICT) to IBS in Malaysia. It is hoping that the CSFs will help the practitioners in implementing IBS by identifying the factors which is critical to the success in their venture in IBS.

Keywords: Industrialised Building System (IBS), Critical Success Factors (CSFs), Malaysia

1. Brief highlights of Malaysian construction industry

The Malaysian construction industry plays an important role in generating wealth to the country and development of social and economic infrastructures and buildings. The industry provides job opportunities for 800,000 people which represented 8% of total workforce (CIMP, 2006). The construction industry is one of the productive sectors that constantly contribute to the economy. Its growth rates fluctuates between extremities that varies from as high as 21.1 percent in 1995 to as low as -24 percent in 1998. Since the 1990's, the contribution of the construction sector to the GDP also fluctuated albeit at a more stable rate varying from a high of 4.8 percent in 1997 to an estimated low of 2.7 percent in 2005 (CIDB, 2008). This shows that the demand for construction is highly sensitive to the developments in other sectors of the economy. Recent data showed that the construction sector growth at 5.3% in 2007 and contributed 2.1% total Gross Domestic Product (GDP) of Malaysia (CIDB, 2008). The contribution to GDP would be much higher if one considers input from the whole supply chain activities of construction from design to maintenance. The total number of contractor registered with the Construction Industry Development Board (CIDB) as in June 2008 is 63,610 (CIDB, 2008). That is a phenomenal number if one compares that to the population. Nonetheless, the industry is under a constant pressure to improve its performance. As in the conventional construction which is a common practice in Malaysia, reinforced concrete frame and brick, beam, column, wall and roof are cast in situ using timber framework while steel reinforcement is fabricated offsite. This method is labour intensive involving formwork fabrication, steel bending and concreting. It requires many wet trades on site such as skill carpenters, plasterers and brick workers. The process can hamper by quality issue, unfavorable site condition, skilled labour shortage and bad weather conditions. One such option is to move towards industrialisation and that is by implementing the Industrialised Building System (IBS) in building construction. With industrialisation, most of the components of a building will be made off-site and manufactured in a factory and brought into site to be assembled. The move to industrialisation is also in line with effort to achieve national housing target of 709,400 units for the period of 2005-2010. Nonetheless, the main reason for Malaysia to move into industrialised construction is due to the influx of foreign labour doing manual jobs in construction. The number of foreign workers in Malaysia has increased from an estimated 0.5 million in 1984 to 0.63 million in 1997, 2.4 million in 1998, 1.9 million in 2006, and an estimated 2.2 million in 2007-2008. In construction sector, Construction Industry Development Board (CIDB) Malaysia reported that 69% (552,000) out of total 800,000 of registered workers as at June 2007 is foreign workers (CIDB, 2007). It is a huge number which distress the stability and growth of domestic economy and created social problems. It is hoping the industrialisation of the industry through mechanisation, pre-fabrication and automation will reduce the number of foreign labour and it eventually will be replaced by high skilled local workforce.

2. Industrialised Building System (IBS) in Malaysia

Industrialised Building System (IBS) is defined 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 work (CIDB, 2003). In other countries, IBS is known as off-site construction, offsite manufacturing and pre-fabrication. The used components are pre-fabricated. Those parts of building that are repetitive but difficult, time consuming, labour intense to cost at site are design and detailed as standardised components at factory. IBS also involve onsite casting using innovative and clean mould technologies (steel, aluminum and plastic). IBS offers benefits in term of cost and time certainty, attaining better construction quality and productivity, reducing risks related to occupational safety and health, alleviating issue on skilled workers and dependency on manual foreign labour and achieving ultimate goal of reducing overall cost of construction. In Malaysia, Construction Industry Development Board (CIDB) has classified the IBS system into 5 categories as follows (IBS Roadmap, 2003):

- Precast concrete framed buildings
- Precast concrete wall buildings
- Reinforced concrete buildings with precast concrete slab
- Steel formwork system
- Steel framed buildings and roof trusses

IBS has been introduced in Malaysia since early 1960s by the use of pre-cast concrete beam-column element and panelised system (Thanoon, 2003). The projects in Jalan Pekeliling, Kuala Lumpur and Rifle Range, Penang used Danish System and French Estoit System respectively. However, due to the leaking issue and high cost in producing panel components the technologies did not take off as planned. However, in 1990s, the employment of foreign labour originally considered as a stop gap measure has become a national security issue. Recent influx of foreign labour has reignited the interest on IBS. IBS Roadmap 2003-2010 was developed and published to steer the direction of IBS implementation and promotion activities and guide the practitioners and policy makers on IBS related issues (IBS Roadmap, 2003). The importance of IBS was highlighted under the Strategic Thrust 5 of the Construction Industry Master Plan 2006-2015 (CIMP 2006-2015) which has been published as means to chart the future direction of the Malaysian construction industry in 2006 (CIMP, 2006). The government through CIDB has introduced exemption of the construction levy (CIDB levy - 0.125 % of total cost of the project according to Article 520) as an incentive on contractors that used IBS at least 50% IBS components in construction of new residential project since 1st January 2007. To create a spill-out effect from public sector projects to private sector project, government had enforced the use of 70% IBS component in all government's new

building construction since 2008. From 2006 to 2010, in approximate of 320 government's projects worth RM 9.43 billion had been identified to be carried out using the IBS. It is a huge market sector for IBS in Malaysia.

3. Problem statement

The initial take up for IBS nonetheless was not as high as first anticipated at this stage particularly from private sector. IBS Survey 2003 stated only 15 % of construction projects used IBS in Malaysia (IBS Survey, 2003). IBS Mid Term Review in 2007 indicated that approximately only 10% of the complete projects used IBS in the year 2006 as compared to forecasting IBS usage of 50 % in 2006 and 70% in year 2008 as projected in the roadmap (Hamid et al 2008). The availability of cheap foreign labour which offset the cost benefit of using IBS is a root cause of the slow adoption. It also relates to sheer cost of investment and the inadequacy of market size. Small contractors are already familiar with the conventional system and for them the technology suit well with small scale projects and therefore not willing to switch to mechanised based system. Furthermore, small contractors lack financial backup and are not able to set up their own manufacturing plants as it involves very intensive capital investment (Rahman & Omar, 2006). It was highlighted by many that the idealism, processes and management and skill sets behind IBS is differs from the traditional method. Lack of knowledge in IBS construction technology is equally important. There are cases, where building projects are awarded and constructed using IBS system but were contribute to the project delays and bad qualities, let alone a hike in construction cost. This has leaves the industry with a noticeable difficulties when using IBS. As a result, the industry is reluctant to embrace in IBS unless it is required by the clients. A wider understanding on the characteristics and what is involved in IBS is needed. Rethinking the old processes is now critical if the industry is to move forward. The industry requires change management and business re-engineering to encourage new mindset. What is needed is guidance on best practices and success factors which can be orchestrated the effort to adopt new construction mechanism. There are consensuses of opinions that IBS best handled as a holistic process rather than just a collection of technological solutions. The approach requires total synchronisation on construction, manufacturing and design processes. It needs emphasis on rationalisation, standardisation, repetition, collaboration, supply chain partnering and more effective planning and project management. The paper provides basis on the factors that are critical to IBS in Malaysia which result to the success or failure on IBS implementation.

4. Research objective

The objective of the research is to identify the Critical Success Factors (CSFs) to IBS construction in Malaysia through a series of case study survey. The identification of CSFs will established a range of limited area of focus which adopters can put their valuable resources on those things which really make difference between success and failure in IBS.

5. Research methodology

The literature search is focused in identifying the potential Critical Success Factors (CSFs) to Industrialised Building System (IBS). A literature review seeks to describe, summarise, evaluate, clarify or integrate the content of information. Completing a literature review is usually a significant intellectual achievement in its own right, requiring the analysis and synthesis of previous work in such a manner that new understandings of that work are uncovered, and the way is opened for new research. Most of the reading materials are published journal, articles, text book and other relevant reading material. The case study is chosen as a research strategy as it permits an informal setting of data collection that reflects the reality of what is happening in the real settings. This approach also allows the researcher to probe each argument in details and obtain rich and more complex data in term of tacit knowledge, perception and human experience which may not be measured using a quantitative approach (Yin, 2003). Case study allows multiple source of evidence including interview, document check and observation. The analysis will be carried out to compare and check the potential CSFs identified in literature search with evidences captured in real construction setting. Future validation work will involves the formulation of questionnaire and follows by quantitative analysis.

6. Literature reviews

The Critical Success Factors (CSFs) to the implementation of Industrialised Building System (IBS) are highlighted as follows:

6.1 ***Good working collaboration*** will solve the problem related to complex interfacing between systems and ensure efficient process sequence in manufacturing plant and at site (Pan *et al* 2007, Na and Liska, 2008; Haas and Fangerlund, 2002).

6.2 ***Effective communication channel*** across the supply chain need to be established in order to coordinate the process and deal with critical scheduling from the beginning until the project completion (Pan et al, 2008; Blissmas, 2007; BSRIA, 1998)

6.3 Successful implementation depends on organisation ability to expedite learning curve from one project to another (Neala *et al* 2003). Therefore, ***continues improvement and learning*** can develop company understanding on the processes and the principal behind it as the knowledge will multiply as experience mount up (Treadway, 2006).

6.4 ***Coordination of design, manufacture, transportation, and installation*** process is vital to the success of IBS (Haas and Fangerlund, 2002; Li, 2006; Vrijhoef et al, 2002 and Lessing, 2006).

6.5 ***Key decisions on strategy, application, design, logistic and detail unit should be made as early as possible between all parties involved*** (Gibb, 1999 & Neale et al, 1993). It should not be used as an afterthought, or as a late solution to shorten construction time, but rather as an integral part of the design from the earliest possible stage of the project (Gibb, 1999 and Blissmas *et al* 2006).

6.6 ***The team members should be involved during the design stages***, working with the designers, to ensure that the design is not taken to a stage where it restricts the benefits that can be brought through the use of this method (Pan *et al* 2008; Blismas, 2007; Sanderson, 2003 and Gibb, 2001).

6.7 Successful implementation requires an ***experience workforce and technical capable in design, planning, organizing and controlling function*** with respect to production, coordination and distribution of components (Warszawski, 1999).

6.8 ***Information and Communication Technology (ICT)*** is vital and reliable support tool to improve tendering, planning, monitoring, distribution, logistic and cost comparison process by establishing integration, accurate data and effective dealing with project documents (Eichert and Kazi, 2007 and Hervas and Ruiz, 2007)

6.9 It requires partnership and ***close relationship with suppliers and sub-contractors*** from the early stage of project sequences (Kamar *et al* 2009; National Audit Office Report (2005); Pan *et al* 2008 & Pan *et al* 2007).

6.10 ***Extensive planning and scheduling*** of activities in advance is critical in which lead to better project performance, coordination, better scope control and ensure smooth project sequence (Haas and Fangerlund, 2002).

6.11 ***Improvement in procurement strategy and contracting*** is important in order to achieve long term success (Pan *et al* 2007 and Pan *et al* 2008). The negotiations, procurement and contract should allow the contractors and manufactures to contribute their knowledge, experience of design, construction and planning of the building.

6.12 ***Risk Management strategy*** is important when to offsite to deal with late design changes, late payment and contract problem (Housing Forum, 2002 and Hassim *et al* 2008). By assessing the potential cause of delays and disruption at all stage of the supply chain, contingency measure can be planned to minimised effect of such effort.

6.13 It requires emphasis on design and ***process standardisation and more effective use on the concept of repetition***. Products are documented in systematic ways to ensure that

everything is repeated in the same manner for installation (Mole, 2001 and National Audit Office Report, 2005).

6.14 High demands will be raised on the ***management of supply chain and logistic activities*** (Lessing *et al* 2005). It needs to be coordinated in a manner that allows the constructors gain the full control of the process with the intention to improve efficiencies and competitiveness (Malik, 2006).

6.15 It also depends on ***'top-down' commitment and corporate motivation.*** This in return will ensure the right motivation and commitment from the whole team (BSRIA, 1998).

6.16 ***Skilled labour*** which is supported by quality training at all level is essential to success of offsite as it is in more traditional form of construction. It requires tremendous education and training effort of trades especially people involved in those handling, positioning and erecting the finished product (BSRIA, 1998 and Thanoon, 2003).

6.17 Any ventures need to ***strategies and business approaches*** and position in the new playing field (Malik, 2006). The management needs to establish clear business need in offsite and build strategic plan around it including effective combination of cost and production knowledge (National Audit Office Report, 2005).

7. Case study analysis

Four case studies have been conducted in Malaysia from August to December 2009. Data collection methods include semi-structured interviews, observations and reference to physical documents. The summary of the case studies depicted in the following Table 1:

Table 1: Analysis of IBS Case Studies in Malaysia

Potential CSFs	*Company A*	*Company B*	*Company C*	*Company D*
Good Working Collaboration	*Yes*	*Yes*	*Yes*	*Yes*
Effective Communication Channel	*Yes*	*Yes*	*Yes*	*Yes*
Continues Improvement and Learning	*Not in any formal form*	*Not in any formal form*	*Not in any formal form*	*Not in any formal form*
Coordination of Design, Manufacture and Construction	*Yes*	*Yes*	*Yes*	*Yes*

Key Decisions on Strategy, Application, Design, Logistic, and Detail Unit Should be Made as Early as Possible Between All Parties Involved	*Not implemented but agreed to be important to IBS*	*Not implemented but agreed to be important to IBS*	*Not implemented but agreed to be important to IBS*	*Yes*
Team members Involved During the Design Stage	*Partly involved*	*Yes*	*Partly involved*	*Yes*
Experienced Workforce and Technical Capable	*Yes*	*Yes*	*Yes*	*Yes*
Information and Communication Technology (ICT)	*Not widely implemented but agreed to be important to IBS*	*Not widely implemented but agreed to be important to IBS*	*Not widely implemented but agreed to be important to IBS*	*Not widely implemented but agreed to be important to IBS*
Close Relationship with Suppliers	*Yes*	*Yes*	*Yes*	*Yes*
Extensive Planning and Scheduling	*Yes*	*Yes*	*Yes*	*Yes*
Improvement in Procurement Strategy and Contracting	*Similar to conventional*	*Similar to conventional*	*Similar to conventional*	*Similar to conventional*
Risk Management	*Not in any formal form*	*Not in any formal form*	*Not in any formal form*	*Not in any formal form*
Design Standardisation and Repetition	*Yes*	*Yes*	*Yes*	*Yes*
Management of Supply Chain and Logistics	*Yes*	*Yes*	*Yes*	*Yes*
Top-down Commitment	*Yes*	*Yes*	*Yes*	*Yes*
Skilled Labour for Site Installation	*Yes*	*Yes*	*Yes*	*Yes*
Strategy and Business Approach	*No*	*Not widely implemented but agreed to be important to IBS*	*Not widely implemented but agreed to be important to IBS*	*Not widely implemented but agreed to be important to IBS*

Results: All cases showed some similarity on the need of good working collaboration, effective communication channel, coordination of design, manufacturing and construction, the need experienced workforce and technical capable, close relationship with suppliers, extensive planning and scheduling,

standardisation, supply chain, top down commitment on IBS and the need for skilled labour for installation. Risk Management and continues improvement ethos is applied in many situation but not initiated as a formal strategies for IBS. Information and Communication Technology (ICT) is agreed by respondents as critical to IBS but yet to be fully utilised in design, planning and quality monitoring. Business strategy including the need to identify IBS niche market is important but not widely implemented by adopters. IBS can be only benefit if decision to use it can be decided as early as possible not as afterthought during the project is agreed by respondents but the majority of projects in Malaysia design as conventional at the first place and need to be redesign again to suit IBS components. This gave some degree of difficulties to adopters. Although the Bill of Quantity (BQ) is different from conventional, there is no effort to change procurement and contract for IBS. Two companies are involved in design and have an in-house manufacturing capability and the remaining cases are project management contractors. The ability to own in-house design and manufacturing capacity will help the adopters to control supply chain and involve in the whole IBS value chain, however, this need high set-up and running cost and would risk and jeopardised the capability of contractor to implement projects as mention in the remaining case studies, so the adopters are undecided on this issues. The result was not concluded at this moment and will be compared with a survey among IBS practitioners in Malaysia in near future.

8. Initial thought so far

The following are author's initial thought based on data from literature research and case studies:

- IBS can be only benefit if decision to use it can be decided as early as possible not as afterthought during the project.

- There is a consensus of opinion that the crucial factors in successful off-site projects lie in good site management, planning and control of overall process in project life cycle. This in turn, leads to recommendation that experience and well-trained workers are the critical for IBS contractors. Project Manager must be able to work with multi trade involved in IBS. Engineers with good technical knowledge in analysis, design, manufacturing and construction have the ability to produce systematic IBS systems. If the components are skillfully designed, erection can be carried out efficiently. Furthermore, complying with good practices in design and construction leads to high quality precast concrete structures.

- The integration of IBS components or modules into the building requires the various parties and supply chain to cooperate closely. This requires very careful definitions and management of interfaces between contractors and suppliers and a good communication channel. It has been suggested that by implementing integrated approach in design and construction, fragmentation gap could minimised.

- Partnering with suppliers and sub-contractors from the earliest project stages is vital to ensure efficient and timely delivery of components and services.

- Components production must also include a commitment to IBS design. Initiating good working collaboration between design team, manufacturer and project coordinator can identify and deal with problem early and push forward improvement in productivity and quality

- There is no reason why construction approach to components production should be radically different from what is used by today's leading manufacturers of consumer product. It should include management and sustained improvement of the production process to eliminate waste and ensure the right components are produced and delivered at a right time, in the right order and without defect. In this respect Malaysian construction industry has a great deal to learn about effective logistics management.

9. Closing remarks

Industrialising construction by way of manufacture of building components and delivery on site exactly when needed is considered an effective way to achieve productivity gains and to make the industry more attractive for new entrance. To move towards industrialisation, Malaysia government has encouraged the use of Industrialised Building System (IBS) construction. IBS is a potential method to improve overall construction performance in term of quality, cost effectiveness, occupational safety & health, waste reduction, image and productivity. With over forty years of laissez faire implementation in Malaysia, IBS has not become widely accepted or used. To expedite the adoption of IBS, factors which are important to IBS need to be identified. The paper investigates the Critical Success Factors (CSFs) of IBS in Malaysia which are limited numbers of areas that ensure successful IBS adoption. The CSFs which has been identified in this paper will assist in our understanding on IBS and improve overall readiness.

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