CONSTRUCTABILITY COMPARISON BETWEEN IBS AND CONVENTIONAL CONSTRUCTION

EHSAN HARIRCHIAN

UNIVERSITI TEKNOLOGI MALAYSIA

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Dedicated to My Beloved Ones:

My precious parents, My lovely sister and brother, and to the soul of

My Grandmother

For their continuous supports and encouragements

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ABSTRACT

The construction industry is globally undergoing a transitional change, starting from a project based industry, and continuing to a more systematic and mechanized product based technology. The Malaysian government has adopted the industrialized building system since the sixties, and experienced great struggles in this field. The system's most significant advantages that have been concluded in many studies are: reducing construction time, reducing total costs, reducing material waste, increasing construction performance and quality of buildings, promoting safe and systematic factory working environment, and providing cleaner and tidier sites. This study has becomes essential since there is not yet an organized body who can provide the necessary information on a comparison between the building constructability of the conventional system and the industrialized building system in the Malaysian construction industry. Many countries currently have serious problems concerning budget, activity duration and reducing construction material waste. Construction materials and waste should be diminish appropriately especially for the high rise buildings. This study will present a comparative case study of two school buildings, which have been built using different construction types in order to investigate the IBS performance and efficiency, and the conventional system in terms of time saving, cost reduction and construction performance issues. Meanwhile, a distributed questionnaire shows that the most important factors for constructability performance are the durational and the financial issues of a construction project. The study concluded that the industrialised building system (IBS) method has a better performance in constructability by being faster, more affordable for large scale projects with less variation, and it provides a better sustainability and waste reduction.

ABSTRAK

Industri pembinaan sedang berhadapan dengan perubahan global, bermula dari industry berasaskan projek, dan berterusan kearah yang lebih sistematik dan berjentera dalam menghasilkan produk berasaskan teknologi. Kerajaan Malaysia telah mengadapatasikan sistem bangunan berindustri sejak tahun enam puluhan dan telah berhadapan dengan pelbagai kesukaran dalam bidang ini. Sistem bangunan berindustri mempunyai kelebihan dari segi: mengurangkan masa pembinaan, kos, sisa pembinaan, menambahbaik prestasi pembinaan dan kualiti bangunan, mempraktikkan persekitaran kerja yang selamat dan sistematik, dan tapak yang lebih bersih. Kajian ini penting kerana terdapat kurang maklumat mengenai perbandingan antara daya binaan dalam kaedah konvensional dan bersistem di dalam industry pembinaan di Malaysia. Kebanyakan negara mengalami maslah serius terutamanya berkenaan bajet, durasi aktiviti and mengurangkan sisa binaan. Bahan dan sisa binaan haruslah dibuang terutamanya untuk pembinaan bangunan- bangunan tinggi. Kajian ini mengetengahkan satu perbandingan antara dua buah sekolah, yang dibina menggunakan kaedah pembinaan yang berbeza untuk mengkaji prestasi sistem bangunan berindustri dan tahap efisien, dan kaedah konvensional dari segi masa, kos and isu isu dalam prestasi pembinaan. Sementara itu, kajian soal selidik menunjukkan faktor utama untuk prestasi pembinaan ialah tempoh dan isu kewangan dalam sesebuah projek. Kajian telah merumuskan bahawa sistem bangunan berindustri (IBS) mempunyai prestatsi pembinaan yang lebih cepat, lebih menjimatkan dalam projek berskala besar yang kurang variasi, mampan dan mengurangkan sisa pembinaan.

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ABBREVIATION	EXPLANATION
CIDB	Construction Industry Development Board
CREAM	Construction Research Institute Of Malaysia
GDP	Gross Domestic Product
IBS	Industrialised Building System
JKR	Jabatan Kerja Raya Malaysia
MHLG	Minister Of Housing And Local Government
OSCT	Off-Site Construction Techniques
PWD	Public Works Department
UBBL	Uniform Building By Low
UK	United Kingdom
USA	United States Of America

CHAPTER 1

INTRODUCTION

1.1 Introduction

The construction industry has a significant consequence to the economy (Kamar *et.al.* 2009) and it might assist as a barometer for indicating the country's economic condition (Tahmasebi, 2012). The Malaysian construction business plays an important role in making investment to the country and development of social and economic infrastructures and buildings. Since the 1990's, the influence of the construction division to the Gross Domestic Product (GDP) also fluctuated although at a more stable rate varying from a high of 4.8 per cent in 1997 to an estimated low of 2.7 per cent in 2005 (CIDB, 2010). This illustrates that the demand for construction is highly sensitive to the developments in other divisions of the economy. The latest data presented that the construction division growth at 5.3% in 2007 and contributed 2.5% total GDP of Malaysia (CIDB, 2010). Concurrently, this industry also provides job opportunities for nearly 1.03 million people which represented 8% of total workforce (Malik, 2006).

With the declaration of the 8th Malaysia Plan, the country continues to embark on the development of affordable and sustainable low and medium cost housing. Nevertheless, the country is facing a difficult task to accomplish the target of 600,000 to 800,000 houses during this period because the conventional building

system currently being practiced by the construction industry is unable to cope with the massive demand (IEM, 2001). Therefore, the industry is under a constant pressure to deliver and to tackle issues on performance, time, budget limitation, safety, shortage of labour, environmental impact, sustainability and demand in affordable housing. To handle with these challenges, Malaysian construction industry has been commended to use innovative construction technique such as the Industrialised Building System (IBS) which has immense inherent advantages in term of productivity, indoor quality, durability and cost (Awomeso *et al*. 2010).

The Construction Industry Master Plan 2006-2015 (CIMP 2006-2015) had been published in December 2006 as means to chart the future direction of the Malaysian construction industry. The effort to promote IBS is highlighted under Strategic Thrust 5: Innovate through research and development to adopt a new construction method (Nawi *et al*., 2009)

IBS has been introduced in Malaysia since the 60's by the use of pre-cast concrete beam-column element and panelised system (Thanoon *et. al.*, 2003). The early attempt to apply IBS in Malaysia was the two pilot projects, the first project was Jalan Pekeliling Flats in Kuala Lumpur in 1964 and the second project was Rifle Range, Penang in 1965 (Din, 1984) had used Danish system and French Estoit System respectively. Both projects were the first time whereby precast elements were used to construct mass houses (Lim Pui Chung, 2006); while these projects have brought bad reputation to IBS due to the problems of leakage as it was based on the European systems and was not appropriate for Malaysian wet toilets and bathrooms (Rahman, 2006). Although the failure of these two projects, the government did not despair and improved its way towards enhancing the experience in prefabricated system field. After the development of precast concrete and steel technology, Malaysian construction sector witnessed many successful projects such as Petronas Twin Towers, Bukit Jalil Sports Complex and Games Village, and the LRT lines and tunnels (CIDB, 2003 a).

The Construction Industry Development Board of Malaysia (CIDB) has redesigned its strategies and formulated a roadmap known as the "Industrialised

Building Systems (IBS) Roadmap 2003-2010". According to the IBS Roadmap 2003-2010, IBS is a construction process that utilizes techniques, products, components or building systems which involve prefabricated components and on-site installation. Normally, this method would involve the assembly of precast elements such as floor slabs, in-filled walls, bathrooms and staircases into place for incorporation into the main units, columns and beams that reduced the amount of site lab our involved in building operations and increased the productivity of the industry. Precast building systems can reduce the duration of a project if certain conditions are met (Nurul, 2012). In the conventional construction method (reinforced concrete frames and brick as infill), the beam, column, wall and roof are cast in situ using timber formworks while steel reinforcement is fabricated on site. This method of construction is labour intensive and involves three separate trades, namely, steel bending, formwork fabrication and concreting (Badir *et al*., 2002).

The most important benefits of IBS system, as mentioned in several studies (Warszawski, 1999), (Thanoon *et al.*, 2003), (CIDB, 2005), (Haron, 2015) and (Nurul *et al.*, 2012) are significantly reducing construction time, reducing total cost, reducing the material waste and increasing quality of buildings, promoting safety, increasing productivity and quality of work through the use of better construction machinery, materials and extensive pre-project planning. Nevertheless, there is still lack in awareness of these benefits among players in the construction sector.

By increasing demand for major infrastructure projects, commercial buildings and housing development programmers, large amounts of construction waste are being produced (Begum *et al*., 2009) and (Alshammari *et al*., 2008) expressed that the current environmental concerns have forced developed and developing countries to reduce air, water and land pollution for sustainable growth. Beside material waste, time and cost spent on the construction process can also be considered as waste as will be studied in this research.

Efficient construction management and perfect constructible can be defined as the efficiency of the process in construction projects. Efficiency in construction process would be constructed project within an affordable cost and shortest time

schedule. Constructability is generally reducing the problems of construction by integrating the construction knowledge into the activities of a construction project. Constructability is a project management technique to review construction processes from start to finish during pre-construction phase and it refers to the effective and timely integration of construction knowledge into the conceptual planning, design, construction, and field operations of a project to achieve the overall project objectives in the best possible time and accuracy at the most cost-effective levels. The more constructible a structure is, the more economical it will be (Schwinger, 2011). Construction time, cost, quality and participation satisfaction have been identified by Dissanayaka (1999) as the main factor for evaluating the constructability of a construction project. Many researches stated that improved constructability has led to significant savings in both cost and time required for completing construction projects (Russel *et al.*, 1992a; Jergeas and Van der Put, 2001).

1.2 Problem Statement

Naturally, construction is not an environmental friendly activity. Many researches proved that construction is a major contributor to environmental pollution. Moreover, according to the complexity of construction projects and disability of the project managers to establish day-by-day program a significant amount of waste would be emerged, which is called Non-value-adding activities and can cause delays and impose financial burden to the project.

Notwithstanding there are numerous studies and researches have been undertaken towards construction time, cost and waste reduction but only few notion are available in order to compare constructability between Industrialised Building System and convention construction system accurately. This may due to the construction industry is considered as fragmented because policy and guideline implementation and practice in the construction are inconsistent among the players

involved. The current IBS initiatives still inherit this problem due to partial implementation of IBS type of construction.

IBS or off-site construction in a controlled environment has better control on human and natural resources which leads that the IBS system has better performance in shortening construction time, reducing construction cost and waste, and enhancement of the occupation health and safety and the quality of buildings. Besides, close tolerance and highest quality control offers by IBS or prefabrication could lead in achieving air tightest and ensuring the optimal use of energy. In sum, IBS has the potential to cover environmental, economic criteria and urban planning which are critical aspects of constructability.

. However, application of IBS offers benefits to adopters in term of cost and time certainty, attaining better construction quality and productivity, reducing risk 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. Therefore, a good cost comparison must be developed to support decision makers in opting IBS over the conventional system.

Many problems were raised in conventional construction system due to its insufficiency that leads to delay and cost overrun in construction projects. People are aware about the problems in conventional construction process but they could not try to find the right preventive solution beside corrective actions. The problem of delay and low project quality has been consistent bad background to the construction industry. A process improvement needs to be taken with indicator that can be used to measure the shortest time and lowest cost of the construction project. The Malaysian construction industry is attempting to promote and use Industrialised Building systems(IBS) for better construction practice with more effectiveness and efficiency, but in terms of constructability and research into the application of constructability concepts for IBS little work has been done. In fact the Malaysian construction industry is still not applying the concepts of constructability in totality and there is lack of constructability research in Malaysia.

Consequently, the main effort of this study is to examine and compare the conventional versus Industrial Building System and their capabilities towards the agenda of the constructability.

1.3 Aim and Objectives of Study

The primary aim of this study is to discover the constructability and performance of construction project in completion time, cost and waste reduction between conventional formwork and IBS formwork for two selected case study. In order to meet the aim, the following objectives are stated:

1- To investigate the important factors that influencing constructability and distinguishing the critical one.

2- To evaluate a comparative study by applying those factors to the IBS and conventional completion cost and time.

3- To appraise the constructability by time, cost, construction waste and investigate performance of construction in the case study of IBS system compared to conventional system.

1.4 Scope and Limitation

In order to achieve the objectives of this study, the research was only focused on the development of construction industry. Data were collected from questionnaire survey while discovering the project schedule time and cost of two case studies. The respondents of the questionnaire survey and interview were from construction

experts such as consultants, contractor and engineers who have experience in both types of construction methods. The case studies were one school building built by IBS and other one a school built by conventional construction system. The case studies have been selected school buildings because in Malaysia and most of the countries this kind of building is a repetitive project that has consistent process, plan and that can be striking. Thus it has more influence on economic and environment. The selected school projects for the case study owned by public work department (PWD) and collected data only confine within the area of Selangor.

1.5 Expected Results

The detailed of the study about the conventional process and IBS, that will use as the guideline and the approaches that can be used will explain detailed in the Chapter 2.

From this study, the following findings may be expected:

1- The main factors in constructability of a construction project will be investigated and applied to compare constructability between conventional and IBS construction.

2- The study will verify whether IBS system in construction is more construct-able than conventional system in term of cost, time and reduce waste in construction projects by having better construction performance.

3- IBS construction is affordable with less variation in project cost.

4- The completion time in IBS is faster than conventional construction.

1.6 Significance of Study

As the time, cost and quality are the most important and their direct effect on economic implications (Dissanayaka, 1999) therefore, the significance of this study is summarized as follows:

- To obviate the concern and possible ambiguity on existence of benefits in using IBS rather than conventional method.
- The investigated factors for constructability performance will assist decision makers to select better construction system and develop a better project planning based on it.
- Time and cost saved over incorporation of IBS instead of conventional method can be measured leading to provocation of those who involved in construction industry to pay more consideration toward Industrialised building system.
- This research was expected to realize the vision of CIDB and the government of Malaysia to promote use of IBS.

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