ACHIEVING INTEGRATED PROJECT DESIGN USING BUILDING INFORMATION MODELING (BIM)

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Specially dedicated…

To my beloved family and friends

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ABSTRACT

Construction industry is labelled as an industry with poor technology enhancement and inefficiency in the design process. In order to increase efficiency in construction industry; various delivery approaches have been introduced. However that does not solved the problem that the industry faced. Construction industry is seem do not capitalised the benefit of visualisation and communication technology to the fullest extent. Construction industry requires new approaches to improve its current performance. The integrated design method is one of the option that can improved design development process for construction project such as by using Building Information Modeling system to provide a collaborative working platform. The main aim of this study is to evaluate the importance of engaging integrated design in construction projects and also evaluate the potential of implementing of BIM to support integrated design in local construction industry. The data are collected through literature review, case study and questionnaire survey. The result of this study has determined the used of BIM is very important in construction as it has many benefit to improve design performance. Other than it is obvious BIM has strong potential to be used to support integrated and collaborative design process.

ABSTRAK

Industri pembinaan dilabelkan sebagai sebuah industri yang lemah dan kurang peningkatan teknologi dalam proses reka bentuk. Dalam usaha untuk meningkatkan teknologi dalam industri pembinaan pelbagai pendekatan dan penyampaian telah diperkenalkan. Walau bagaimanapun ianya tidak menyelesaikan masalah yang dihadapi dalam industri. Industri pembinaan masa kini dilihat sebagai tidak mendapat memanfaat daripada teknologi visualisasi dan komunikasi dengan sepenuhnya. Industri pembinaan memerlukan pendekatan baru untuk memperbaiki prestasi semasa. Kaedah reka bentuk bersepadu adalah salah satu cara yang boleh memperbaiki proses pembangunan reka bentuk untuk projek pembinaan seperti dengan menggunakan sistem Pemodelan Maklumat Bangunan (BIM) bagi menyediakan satu platform yang boleh bekerjasama. Tujuan utama kajian ini adalah untuk menilai kepentingan melibatkan reka bentuk bersepadu dalam projek-projek pembinaan dan juga menilai potensi melaksanakan BIM bagi menyokong reka bentuk bersepadu dalam industri pembinaan tempatan. Data dikumpulkan melalui kajian lepas, kajian kes dan kajian soal selidik. Hasil kajian ini telah menentukan bahawa pengunaan BIM adalah sangat penting dalam pembinaan kerana ia mempunyai kebaikan untuk meningkatkan prestasi reka bentuk. Selain daripada itu, jelas menunjukkan bahawa BIM mempunyai potensi yang kukuh untuk digunakan bagi membantu proses reka bentuk bersepadu dan kerjasama.

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LIST OF ABBREVIATIONS

ABBREVIATION		FULL NAME
AEC	-	Architect, Engineering, Contractor
AIA	-	America of Institution Architect
AGC	-	Associated General Contractors of America
BIM	-	Building Information Modeling
DB	-	Design Build
DBB	-	Design-Bid-Build
DBIA	-	Design Build Institute of America
GMP	-	Guaranteed Maximum Price
ICT	-	Information and Communication Technologies
IPD	-	Integrated Project Delivery
JIT	-	Just- In-Time
MEP	-	Mechanical-Electrical-Plumbing
NIBS	-	National Institute of Building Sciences
PWD	-	Public Work Department
RFI	-	Request For Information

CHAPTER 1

INTRODUCTION

1.1 Background of Study

The Architect, Engineer and Contractor (AEC) industry is labeled as a low-technology and inefficient industry (Latham 1994; Egan 1998; Gallaher *et al*. 2004). In recent years various delivery approaches are developed from computer-aided design and manufacturing such as lean construction, modularization, prefabrication and Just-In Time (JIT) and they are currently adopted by some sectors and specialists in construction (SwerealVF 2008; Kunz and Fischer 2009; Cohen 2010). However, there has been a limited focus on the necessary interrelationship between all of these approaches.

Since 1940s, as the buildings became more complex, the construction processes needed to be more specialized, and needed a master builder to direct the process from inception to completion, so the design-bid-build widely used as project delivery method in the United States, thereafter (Miler *et al*., 2000). But as Gallaher *et al.* (2004) in their research also found out, this approach resulted in inefficiency, high levels of fragmentation, high costs and inadequate interoperability. Subsequently, in 1960s the construction management was introduced as a solution to these problems. Although this

approach has been providing value to owners, it has not changed the underlying problem of fragmented project teams and information (Kent and Gerber, 2010).

1.2 Problem Statement

Today, in order to make construction process more efficient, various approaches of project delivery methods have been introduced, though the problem that extracts project performance does still exist. The expense and complexity of construction projects have brought the problems of the construction industry to the forefront of the owner's mind. Besides, Kymmell (2008) claimed that the largest problem in the planning and construction of building projects is the improper visualization of the project information, i.e unless the information is fully visualized, understood, and communicated, it cannot be represented correctly in the contract documents and consequently problems are created during construction.

The traditional project delivery system has many limitations and the owners are usually disappointed of current practices due to the continual appearance of problems in project. These problems are always related to the design, costs and relationship among team players.

Chuck Thomsen *et al*. (2009) have identified some problems of the traditional project delivery systems. Chuck Thomsen *et al*. (2009) discovered that a design effort will be wasted if the information about cost, constructability and owner's non-program preferences are considered based on the designer decisions and other parties are not involved in decision making. Besides that, Chuck Thomsen *et al*. (2009) also indicated the construction costs are high because general contractors estimate the price based on the designs and the designs are involved with uncertainty. In addition, designers tend to use larger spaces than necessary in order to give plenty of room for trade installations,

resulting in larger buildings than needed. While if the designers were coordinating with trade contractors from the beginning, the space would be provided in an adequate size.

Moreover Chuck Thomsen *et al*. (2009) stated that the change orders unusually occur because architects design a building without considering the site situation. Therefore, the trade contractors suggest opinions and recommendations to architects in order to improve productivity and constructability, but they are excluded from the drawings.

Chuck Thomsen *et al*. (2009) identified relationships among the team members are important. This is because a bad relationship will bring the adversarial to project and disputes happen often in a project. The contractual structure encourages each party to look to its own interests rather than the interests of the project as a whole. Lack of contractor involvement in the design phase reduces the level of common understanding of the project among the players, resulting in more mistakes, misunderstandings and blame.

Besides that, AIA California Council (2007) has reported the conventional delivery methods often imply a divide between build team members i.e the work is handed off from one member to the next throughout the process. Figure 1.1 indicates that in traditional delivery method, the risk in construction documentation should reduce, in order to increase the ability to control cost and reduce the cost of design changes. Consequently the project will experience delay and cannot be successfully completed in accordance with the planning. However, the building SMART design method, promotes greater collaboration between build team members earlier in the lifecycle. The team members will work together during the design phase, enabling to control the costs in an early stage before the project proceeds into the construction phase. Thus, this method can improve the constructability and expedite construction.

Moreover, director-general of Public Works Department (PWD), Datuk Seri Dr Judin Abdul Karim said that the department, in supporting the government's desire to maximize the value of investment throughout the development plans, would utilize and enforce various ICT solutions in its strategies. This includes spearheading the adoption and usage at all levels of Building Information Modeling (BIM) software and applications in building design. (25th July 2010, New Straits Times)

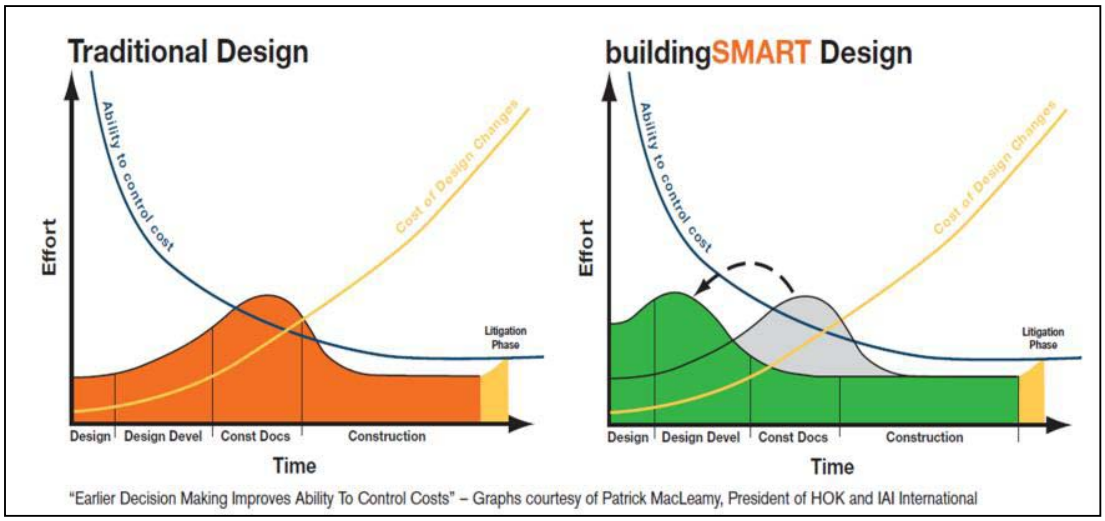

Figure 1.1: Graph of Earlier Decision Making Improves Ability to Control Costs

Source: McGraw Hill Construction (2007)

1.2.1 Design-Bid- Build

The design-bid-build project delivery method is based on an owner having the design prepared by a design team (an architect and consultants) so that several construction companies can bid on the construction of the project after the plans have been completed (Kymmell, 2008). The concept of the design-bid-build is linear process and the construction team is generally not supposed to be a part of the planning process, which it will cause lack of the early communication between the design and construction

teams and often leads to oversights and misunderstandings regarding the details of the project.

Hardin (2009) has identified several problems in the design-bid-build delivery method. In this method, contractor's bids vary wildly because of both internal and perceived external issues on the project. First, if a general contractor has too much work on hand, they might bid the project higher. Since the contractor wants to complete the work, so they justify the additional costs through staff adjustment, overtime, and other overhead costs to complete the work. Second, the general contractor will gauge the aptitude of the design team based on the documents because the collaboration with the design team is very important in a whole process construction. They will raise or lower their costs depending on the detail and accuracy of the documents. Lastly, the contractor has taken the risk if they are not selected. Basically, contractor will spend amount of time and money to producing a bid, and there is a high risk for not being rewarded for that investment. Moreover, if they are low bidder on the project, the owner reserves the right to reject any of the bids regardless of the cost.

1.2.2 Design-Build

The Design-Build Institute of America (DBIA, 1994) defines that the design-build method of delivery is a system of contracting whereby one entity performs both architectural/engineering and construction under one single contract. Under this arrangement, the design documents are complete and free from error (design- builder takes the risk). The selection process under design-build contracting can be in the form of a negotiation process involving one or more contracts, or a competitive process based on some combination of price, duration, and proposer qualifications. Portions of the overall design or construction work can be performed by the design-build entity or subcontracted out to other companies that may or may not be part of the design-build

team. This process is an attempt to involve the design and construction teams in collaboration throughout all phases of the project.

1.2.3 CM-at- Risk

The construction manager acts as a consultant to the owner in the development and design phases but also act as a general contractor during the construction phase. Construction manager not only act for owner's interest, but the construction manager must manage well and control construction costs to not exceed the GMP (Hardin, 2009).

1.2.4 A New Concept of Delivery-Integrated Project Delivery

Integrated project delivery (IPD) is a new form of project delivery. AIA California Council (2007) has define integrated project delivery (IPD) is a project delivery approach that integrates people, systems, business structures and practices into a process that collaboratively harnesses the talents and insights of all participants to reduce waste and optimize efficiency through all phases of design, fabrication and construction. IPD has materialized as a delivery method that could most effectively facilitate the use of building information modeling (BIM) for construction project. The Table 1.1 shows the comparison of traditional delivery and integrated project delivery method.

Table 1.1 Comparison of Traditional Delivery and Integrated Project Delivery Method.

Traditional Project Delivery (The past)		**Integrated Project Delivery (Now...the future)**
Fragmented, assembled on "minimum-necessary" or "just-as-needed" basis, strongly hierarchical, controlled	**Teams**	An integrated team entity composed key project stakeholders, assembled early in the process, open, collaborative
Linear, distinct, segregated; Knowledge gathered "just-as-needed"; Information hoarded; Silos of knowledge and expertise	**Process**	Concurrent and multi-level; Early contributions of knowledge and expertise; Information openly shared; Stakeholder trust and respect
Individually managed, transferred to the greatest extent possible	**Risk**	Collectively managed, appropriately share
Individually pursued; Minimum effort for maximum return; (Usually) first-cost based	**Compensation/ reward**	Team success tied to project success; Value-based
Paper-based, 2 dimensional; Analog	**Communications/ technology**	Digitally based, virtual; Building Information Modeling (3, 4 and 5 dimensional)
Encourage unilateral effort; Allocate and transfer risk; No sharing	**Agreements**	Encourage, foster, promote and support multi-lateral open sharing and collaboration; Risk sharing

1.3 Aims of the Research

The aim of study is to evaluate the potential of Building Information Modeling (BIM) application toward achieving integrated design in local construction industry.

1.4 Objective of the Research

The objectives of the study are as follows:

1. To evaluate the importance of engaging with integrated design in building work.
2. To explore BIM features to support the integrated design.
3. To evaluate the potential application using Building Information Modeling (BIM) to support integrated design in local construction industry.

1.5 Scope and Limitations of the Study

The study is focused on evaluating the industry acceptance of BIM in a collaboration working environment. This study is limited by the following aspects:

i. Questionnaire survey distributed to the construction stakeholder in Johor Bahru areas only.
ii. Case study for BIM application only possible for outside Malaysia. Due to lack of any case study of BIM application found in Malaysia.
iii. This research also will not cover the matters related the agreement and contracting using this type of method.

1.6 Importance of Study

The results from this study can be guidance and reference sources to all parties involved in the construction industry such as architects, contractors and clients which need to consider the project delivery method especially in the design stages. The integrated design by using Building Information Modeling gives an idea to the client,

consultant and contractor about the use of the information technology in the design stages. Building Information Modeling (BIM) has lots of features to support the integrated design. Therefore, select the right delivery method can increase constructability of a project and minimize the costs of project, duration of construction, unexpected risk, and etc. Finally, it is believed that the result will also able to solve the communication among the team member in a construction project.

1.7 Brief Research Methodology

Five stages are developed in this study. The first stage of the study identifies the current project delivery issues and addresses the problem. After that, the aims and objectives of study are developed. The second stage is the literature review to understand the topic of study. The third stage is data collection through the questionnaire survey. After that, the collected data is analysed and discussed. The last stage is presenting the data and making the conclusion. Figure 1.2 represents the research flow chart.

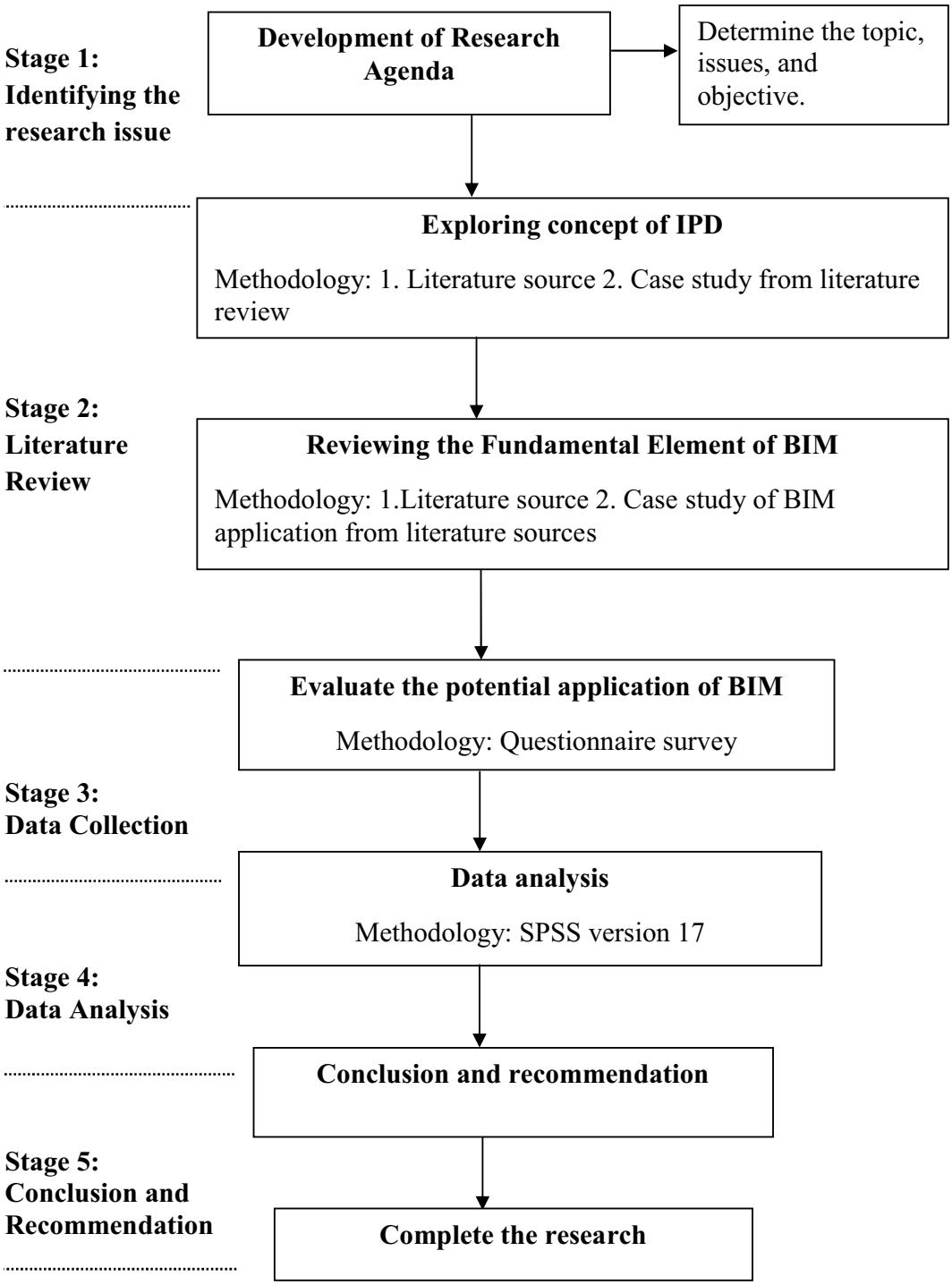

Figure 1.2: Research Flow Chart