BUILDING INFORMATION MODELING (BIM) AND DESIGN AND BUILD PROCUREMENT IN BUILDING CONSTRUCTION PROJECTS

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DEDICATION

To my beloved parents, husband, sons and my family members for their endless love, care and support....

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ABSTRACT

The Building Information Modeling (BIM) implementation is to create a centralised knowledge sharing resource that contains all the necessary design and operational information about the project. BIM is a collaborative approach to design and delivery embraced by various construction teams in the construction projects such employers, engineers, architects, quantity surveyors and contractors. Discussing in the context of the most suitable procurement to be used, with regards to the use of BIM, the Design and Build (D&B) approach is highlighted as the best building procurement of the design-to-construction business process. D&B process was developed to consolidate responsibility for design and construction into a single contracting entity. Typically in the traditional pre-construction D&B scenario, the contractor receives a set of client's requirements. However, the contractor often faced problems in the form such that the requirements are unclear, the scope of work are not adequately stated and there are missing elements which normally led to changes in the design that involves a great financial and time related. BIM is going to be particularly beneficial for D&B procurement, because the involvement of the contractor at earlier stage should be necessary for the client receiving the design proposal as BIM model; so the design model can be visualised and modified and corrected in order to fit all the requirements. Therefore this study is carried out to investigate what are the factors which facilitate the D&B procurement as the suitable approach for BIM adoption in construction projects. This is basically a descriptive study and the methodology used is essentially based on case law analysis and review. The analysis revealed that, propensity of adopting D&B procurement and the adoption of BIM based on these factors: improve the communication; closer collaboration; liability and legal relationships are specifically determined; cost effective and cost certainty; and lastly, a saving in overall time from conception to completion with reductions in design and construction period.

ABSTRAK

Perlaksanaan “Building Information Modeling” (BIM) adalah untuk mewujudkan perkongsian sumber pengetahuan berpusat yang mengandungi semua reka bentuk yang diperlukan dan maklumat operasi mengenai projek. BIM adalah pendekatan kerjasama untuk merekabentuk dan penyiapan kerja oleh majikan, jurutera, arkitek, juruukur bahan dan kontraktor dalam projek-projek pembinaan. Dalam konteks penggunaan BIM, perolehan yang paling sesuai dan terbaik untuk digunakan adalah dengan pendekatan Reka dan Bina (D&B). Proses D&B dibangunkan adalah untuk menyatukan rekabentuk dan pembinaan menjadi satu entiti kontrak tunggal. Biasanya dalam senario pra-pembinaan D&B secara tradisional, kontraktor akan menerima satu set kehendak pelanggan. Walaubagaimanapun, kontraktor yang sering berhadapan masalah dimana keperluan yang disenaraikan adalah tidak jelas, skop kerja tidak dinyatakan secukupnya dan terdapat unsur-unsur kehilangan informasi yang biasanya membawa kepada perubahan dalam rekabentuk yang melibatkan isu kelewatan dari segi masa dan masalah kewangan yang besar. BIM akan menjadi sangat bermanfaat untuk perolehan D&B kerana penglibatan kontraktor di peringkat awal yang membolehkan pelanggan menerima cadangan rekabentuk sebagai model BIM; jadi model rekabentuk boleh dilihat dan diubahsuai serta diperbetulkan dalam usaha untuk memenuhi semua keperluan. Oleh itu kajian ini dijalankan untuk menyiasat apakah faktor-faktor yang membenarkan bahawa perolehan D&B ini sebagai pendekatan yang sesuai untuk diterimapakai dalam projek-projek pembinaan yang melaksanakan BIM. Pada dasarnya, ini merupakan kajian deskriptif dan kaedah yang digunakan pada asasnya berdasarkan analisis dan kajian ke atas kes undang-undang. Analisis ini mendedahkan bahawa, kecenderungan perlaksanaan perolehan D&B dan penggunaan BIM adalah berdasarkan faktor-faktor ini: meningkatkan komunikasi; kerjasama yang lebih erat; liabiliti dan hubungan di dalam undang-undang ditentukan secara khusus; kos efektif; dan akhir sekali, penjimatan masa secara keseluruhan dari peringkat rekabentuk dan tempoh pembinaan.

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LIST OF ABBREVIATIONS

Abbreviation		Full Name
BIM	-	Building Information Technology
CAD	-	Computer Aided Design
3D	-	Three-dimensional
D&B	-	Design and Build
CPM	-	Critical Path Method
RFI	-	Request for Information
NSW Government	-	New South Wales Government
FHWA	-	Federal Highway Administration
RICS UK	-	United Kingdom Royal Institution of Chartered Surveyor
S.O.	-	Superintending Officer
CMA	-	Construction Management Agreement
SA	-	Supplemental Agreement (SA).

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CHAPTER 1

INTRODUCTION

1.1. Background of Research

Building Information Modeling (BIM) is a technology that has improved the way structures are designed and built, it is an improvisation of Computer Aided Design (CAD) that involves various parties than just an architect and engineer. (Weygant, 2011)

Brad Hardin (2009) opined BIM as *"the virtual construction of the structure that contains an intelligent model in a single server which can be shared among the project teams in order to increase the amount of communication and collaboration among the owner, architects, engineers, quantity surveyor and contractor."*

McAdam (2010) has the same opinion and states that *"BIM is a collaborative approach to design and delivery embraced by various construction teams in the construction projects such employers, engineers, architects, quantity surveyors and contractors."*

A similar view is shared by Koko Udom (2012) that *"BIM is a process involving the collaboration of consultants, contractors, sub-contractors, specialist managers, fabrication modelers and facility managers."*

Sun *et.al* (2015) states that *"the essence of construction project management in accordance with the concept of BIM is to integrate information about the planned and then executed building structure in the form of a digital building model including data on architecture and design, and other information necessary for the implementation and operation of the constructed facility. All the data that are now collected in the form of a model were previously scattered in sub-sector documentation."*

According to Chuck Eastman *et.al* (2008), *"utilizing BIM technology has major advantages for construction projects that save time, money, smoother and lead to better plan of construction process, reduces the potential errors and conflict for the benefits all members of the project teams."*

Design professionals especially Architect and Engineers primarily tend to think BIM as a tool for creating scaled, three-dimensional (3D) as well as virtual representation of actual buildings to be constructed (K Smith and Tardiff, 2009). However, according to Jane Foulkes (2012), *"BIM is not more than just 3D modeling, it helps in changing the way of building procurement with collaborative and integrated working processes which saving approach through cost, time and material at every stage in the construction."*

Wei Lu *et.al* (2013) looks at BIM in a different perspective and reiterates that *"BIM provides a new working logic in construction in terms of collaboration. Project team being able to work more collaboratively and perform more effectively where project can be completed more efficiently. As a result, all the stakeholders can benefit from time saving, cost saving and good quality."*

1.1.1. The Suitable Procurement To Be Used For BIM

Discussing in the context of the most suitable procurement to be used, according to Eastman (2008) with regards to the use of BIM, the *"Design and Build (D&B) approach is the best building procurement of the design-to-construction business process. D&B process was developed to consolidate responsibility for design and construction into a single contracting entity."* According to Foulke (2012), typically in the traditional pre-construction D&B scenario, the contractor receives a set of client's requirements. However, the contractor often faced problems in the form such that the requirements are unclear, the scope of work are not adequately stated and there are missing elements which normally led to changes in the design that involves a great financial and time related.

Foulke (2012) added that *"BIM is going to be particularly beneficial for D&B procurement, because the involvement of the contractor at earlier stage should be necessary for the client receiving the design proposal as BIM model; so the design model can be visualised and modified and corrected in order to fit all the requirements."*

1.2. Problem Statement

"BIM is a collaborative approach to construction that involves integrating the various disciplines to build a structure in a virtual and visual environment. The essence of BIM implementation is collaborative working process in construction work" (Wei Lu *et.al,* 2013).

While BIM offers new methods for collaboration to all contracting parties and all the efficiency that the technology can provide, there are significant contractual issues which arise in BIM implementation. The creation and use of a BIM must be supported by a specified contracts that may properly allocate or share risk and liability among the contracting parties.

According to Udom (2012), by incorporating BIM in construction project, there will be a transition from a traditional practice of an entire project and by adopting BIM, it is expected to integrate the barriers between the designer teams and the contractor as practice in a traditional procurement. Eastman (2008) states that by implementing BIM, any variations of the design to construction phases in construction project will be collaborated at earlier stage during the design phase between the design disciplines and contractor . The variation process in each phases of design and construction can cause significant changes in the relationships and the contractual agreement between the contracting parties.

Eastman (2008) states that with regards to the collaboration process of BIM, D&B approach is the best building procurement of the design-to-construction business process because of the project team works collaboratively during the design phase. This is further supported by Foulke (2012), who states that BIM is going to be particularly beneficial for D&B procurement, because the involvement of the contractor at the earlier stage of the construction process..

Brad Hardin (2009), of *"The Design-Build Institute of America (DBIA) stated, currently there is no specific BIM contract; but he does strongly recommended that the D&B frameworks is the best structured procurement system to facilitate the use of BIM because of the early formation and collaboration of the project teams."*

In Weygant's words (2011), in any type of project, the more collaboration that occurs, the better the flow and the faster it can be delivered. In BIM collaborative environment, it forces the industry to rethink how projects are delivered. He added in traditional project delivery method, there is a little collaboration among the parties. Therefore, in collaborative environment, D&B is the most suitable practice where the owner, architect, contractor and subcontractors collaborate at early stage of the project delivery.

Therefore, based on the opinion and ideas generated by various academic discourse it may be summed up that the best procurement practice in BIM project delivery is through D&B method. Based on that premise, this study will investigate what are the factors which facilitate the D&B procurement as the suitable approach for BIM adoption in construction projects.

1.3. Research Question

What are the factors and why is D&B procurement process is the best approach in adopting BIM application in building construction projects?

1.4. Objective

The main objective of this study is to investigate on the propensity of D&B procurement adoption in projects which use BIM concept.

1.5. Significant of Research

In order for all the efficiencies and cost saving that BIM technology can provide in a construction project are to reaped, it must be supported by a suitable procurement method and contracts. The purpose of this study is to investigate on the propensity of the D&B procurement adoption for projects which use BIM concept. The study would also provide an overview of why D&B method of procurement is more suitable to BIM implementation projects.

1.6. Scope of the Research

According to Eastman (2008) with regards to the use of BIM, the D&B approach is highlighted as the best procurement. D&B process is able to consolidate responsibility for design and construction into a single contracting entity.

This study would relate to the Standard Form of Design and Build Contract PWD Form DB (Rev 1/2010).

The cases with legal issues concerning cost and time overrun in the Malaysian construction projects have been selected as the data for documentary analysis. In the view of Morledge (2006), *"the cost issues are important because the need of price certainty can influence both project timing and the procurement strategy to be used. In order to get price certainty, the design of the project should be completed before construction commences because preparation and changes in design process will cause delay towards the project; except where design and build procurement strategy is adopted."* According to Morledge project timing will influence the work programme of the project. By setting unachievable work

programme will result in overruns. A late delivery can occur severely effect on the cost and value of the project.

These cases have been obtained from the Malayan Law Journal accessible through Lexis-Nexis Malaysia via online database which is subscripted by Perpustakaan Sultanah Zanariah, Universiti Teknologi Malaysia.

1.7. Research Methodology

This study has been done systematically through different stages. There are important outcomes to be achieved in each of the particular stage. There are divided in five well planned stages to reach the purpose and objective of this study. These stages briefly described in the following paragraph for a more thorough understanding.

1.7.1. Stage 1 - Identification of the Title and Research Problem

Preliminary study on the background and the knowledge of the subject matter has been carried out through extensive reading and understanding of the concepts of the BIM practice in construction project.

1.7.2. Stage 2 - Literature Review

After the research problem and objectives have been identified, the second stage of the study shall be executed by collecting all the relevant the secondary data shall be executed from books, journals, online articles, etc.

1.7.3. Stage 3 - Data Collection

This stage is the most essential stage towards achieving the objective of this study. The data collection is based on primary data consist of selection of related legal cases.

1.7.4. Stage 4 - Research Analysis

Documentary analysis is based on the analysis of the legal cases which have been identified. The cases have been analysed extensively with special attention paid on the factors on the propensity of D&B procurement as the suitable procurement method for construction projects adopting BIM concept.

1.7.5. Stage 5 - Preparation of Research Report

The writing up of the research report was done to document all the result into an organised manner. The literature review and all research analysis was systematically arranged in accordance in the format required by. The compilation of the research report indicated the conclusive completion of this study and compiled with proper binding.

1.8. Conclusion

In writing this chapter, all the subject matters are covered following a systematic order. Firstly, the brief introduction on the background of the title has been made. Secondly, issues have been identified in the problem statement. Thirdly, the issues may occur in the adoption of the BIM process has been stated in the research question. Fourthly, the objective of the study has also been determined. At the Fifth stage, the significance of conducting this study has been elaborated. The scope of the study due to the limitation of time is explained after that and finally the process of data collection has also been mentioned in the Research Methodology section. The following Chapter Two would be a discussion on disciplines related to the study which comprise of BIM concept and D&B procurement. The discussion on both interdisciplines would provide an avenue for a better comprehension of the subject matter of the research. **Figure 1.1** shown the process and methods of approach for the study.

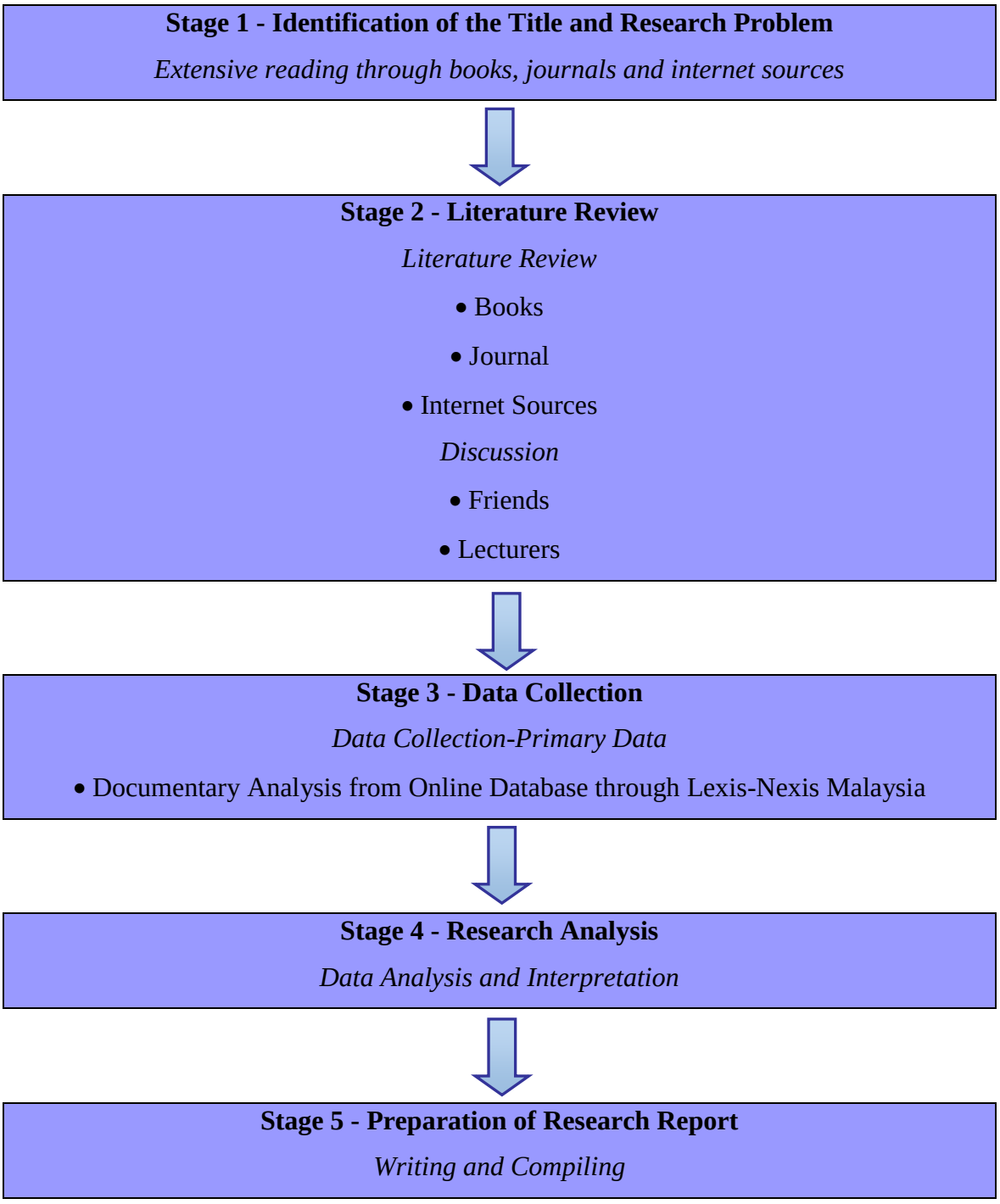

Figure 1.1 - *Process and Methods of Approach for the Study*

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