MINIMIZING CONFLICTS DURING CONSTRUCTION STAGE BY USING BUILDING INFORMATION MODELING

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To Farah Azmin who stood beside her husband at every single step of the way,
to Amsyar Darwisy who sacrificed precious time, attention and love with his father,
and to people around me especially my parents who constantly encouraged,
supported and committed to me

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ABSTRACT

Public Works Department of Malaysia (PWDM) is one of the main governments' technical agency in Malaysia. PWDM has supervised numerous government projects but still faces problems such as delays and variations due to conflicts during construction. The main study is to investigate the effectiveness of applying Building Information Modeling (BIM) in managing conflicts during construction. The results of the analysis were established from surveys of questionnaires, interviews and lastly from PWDM's own database. The analysis was based on mixed method which combines the qualitative and quantitative analysis approach and finally comparing it with literatures that discusses conventional projects and projects using BIM. This study which focuses on the conflicts during construction, finds that conflicts are attributed to the lack of communication and coordination which eventually contributes to the project delay. This study was conducted in order to find the root cause of the problem and proposing an action plan that utilises the BIM approach in order to properly manage conflicts during the construction stage. It has also come into attention that although the proposed measures for conflict management through BIM is practical and feasible, it will still encounter some resistance. This form of resistance has been identified and appears in the form of cognitive, resources, motivational and political. The results have also provided evidence that through BIM utilisation, conflicts during the construction stage can be minimized. Other beneficial factors of applying BIM are improved communication and coordination among the projects stakeholders. This research study has also encountered some challenges due to the limitation of BIM expertise and the small number of PWDM projects that actually utilises the concept of BIM. It is with great hope that this research study will spur and generate greater interest for those whom are involved in BIM and Architecture, Engineering and Construction (AEC) industry as it provides an extension of BIM's current knowledge base especially in the aspect of construction stage conflict reduction.

ABSTRAK

Jabatan Kerja Raya (JKR) Malaysia merupakan salah sebuah agensi teknikal kerajaan yang utama di Malaysia. JKR telah banyak menyelia projek-projek kerajaan tetapi masih menghadapi masalah seperti projek lewat dan perubahan kerja yang disebabkan oleh konflik semasa pembinaan. Tujuan utama kajian ini adalah untuk mengkaji keberkesanan penggunaan *Building Information Modeling* (BIM) dalam menguruskan konflik semasa pembinaan. Keputusan analisis adalah berdasarkan kajian soal selidik, temubual dan juga daripada pangkalan data JKR iaitu berdasarkan kaedah analisis kualitatif dan kuantitatif. Hasil keputusan analisis adalah bersandarkan kajian literatur yang berkaitan iaitu antara projek konvesional dengan projek yang menggunakan BIM. Hasil utama kajian keatas konflik semasa pembinaan menunjukkan ia boleh berlaku akibat daripada komunikasi dan koordinasi yang kurang berkesan dan menyumbang kearah kelewatan projek. Hasil dapatan kajian digunakan untuk pelaksanaan pelan cadangan dengan menggunakan pendekatan BIM dalam menguruskan konflik semasa pembinaan. Namun terdapat beberapa kekangan yang telah dikenalpasti dalam melaksanakan pelan cadangan tersebut iaitu dari aspek halangan kognitif, sumber, motivasi dan politik. Keputusan juga menunjukkan bahawa pelaksanaan BIM dapat membantu mengurangkan konflik semasa pembinaan. Selain faktor tersebut, penggunaan BIM juga dapat meningkatkan komunikasi dan koordinasi antara semua pihak yang terlibat. Kajian ini mendapati terdapat kekangan dalam melaksanakan kajian ini dimana pakar BIM dan projek JKR yang menggunakan kaedah BIM adalah masih terhad di Malaysia. Adalah menjadi harapan, kajian ini akan menjadi salah satu sumber rujukan dan inspirasi bagi mereka yang terlibat dalam BIM dan industri Arkitek, Kejuruteraan dan Pembinaan (AEC) khususnya, kerana kaedah ini merangkumi ilmu asas dalam BIM terutama dalam mengurangkan konflik semasa pembinaan.

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LIST OF ABBREVIATIONS

AEC	Architect, engineering and construction
BIM	Building Information Modeling
BOS	Blue Ocean Strategy
CLD	Causal Loop Diagram
EOT	Extension of time
HODT	Head of Design Team
HOPT	Head of Project Team
IBS	Industrial Building System
ICT	Information and communication technology
JKR	Jabatan Kerja Raya
LAD	Liquidated Ascertain Damages
M&E	Mechanical and electrical
NCI	National Cancer Institute
PSG	Problem Solve Governance
PWDM	Public Work of Department Malaysia
RII	Relative importance index
RISP	Registered IBS System Provider
RMK-9	Rancangan Malaysia ke-9
SKALA	Sistem Kawal dan Lapor
SPSS	Statistic Package for Social Science
VO	Variation order

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CHAPTER 1

INTRODUCTION

1.1 Introduction

The construction industry is in need to move forward through ‘change’; from the traditional or conventional method to the Building Information Modelling (BIM) method. This involves the entire project phase, from the project planning up until the completion and handing it over to the operators. Wong et al. (2013) stated that “Due to low productivity levels in the construction industry, there is a continuous urge for its improvement by using those innovative techniques and methods already adopted by other industries”.

Building Information Modeling (BIM) is a modern technology which was introduced by the Architecture, Engineering and Construction (AEC) industry. In Malaysia, BIM had formally surfaced during the early year of 2007 by the Public Works Department (Latiffi et al., 2013). There are many definitions of BIM and according to Penn State Department Architectural Engineering (2010), “Building Information Modelling (BIM) is a process focused on the development, use and transfer of a *digital information model* of a building project to improve the design, construction and operations of a project or portfolio of facilities.”

Figure 1.1 shown the BIM cycle phases, based on an article linking about the daily life of BIM (Dispenza, 2010), which can carry information downstream all the way from the planning phase up until its operational and maintenance phases.

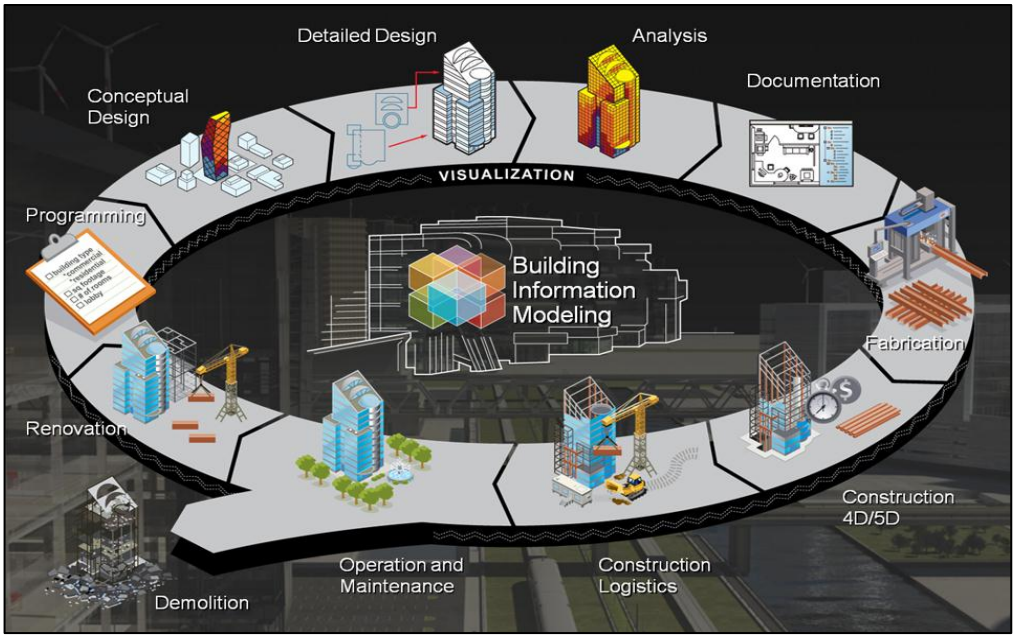

Figure 1.1: BIM Cycle Phases (Adopted from Buildipedia.com., 2010)

Public Works Department of Malaysia (PWDM), also known as Jabatan Kerja Raya (JKR) started using BIM in their pilot projects, which were the National Cancer Institute of Malaysia, followed by SMK Meru Raya (Ipoh, Perak), SK Tanjung Minyak 2 (Melaka), SPRM Administration Building (Shah Alam, Selangor) and Klinik Kesihatan Maran,-KK Jenis 5 (Maran, Pahang) (Latiffi et al., 2013). Latiffi et al. (2013) also states that the intention of BIM application in these pilot projects are to facilitate problems solving during the construction stage, as the aims of BIM is to prevent disputes between the different construction players and parties. According to Peter et al. (1997), disputes require quick resolutions and it is extension from the conflicts if it is not properly managed.

As interest in the BIM workflow is growing immensely amongst industry players (Rooney, 2014), many agencies including the public sector are looking forward to inspire and influence designers and contractors to team up and getting actively involved in applying the BIM method. Being a technical agency, PWDM

has initiated to kick-off the pilot projects in order to identify the benefits of using BIM (JKR, 2014).

The intention of this research is to explore BIM potential in reducing conflicts during the construction stage since that a common project environment hugely draws in potential conflicts (Verma, 1998). These conflicts come in the form of scope change, design variation and drawing discrepancies among disciplines due to the lack of communication and coordination during the planning and design stage. (Mohamud, 2014).

1.2 Background of the Problem

Generally, project faces problems during the construction stage (Verma, 1998) and this will eventually lead to cost and time overruns (So, 2004). A study by Memon et al. (2011) on causative factors leading to construction cost overrun and delay in time for projects in Malaysia is mainly due to these factors:

- Poor design
- Unrealistic contract requirements and duration
- Lack of experience
- Late delivery of materials and equipment
- Poor relationship between the management and labour
- Delay in the preparation and approval of drawings
- Inadequate planning and scheduling
- Poor site management and supervision resulting in errors during construction.

According to Whitfield and Blackwell (2012), the main cause of conflicts is due to the misunderstanding from poor communication practices in the project.

In the PWDM organization, the Business Sector is divided into several branches which is responsible in managing projects given by the clients (government sector), which involves the planning stage up until handover. Projects are led by the Head of Project Team (HOPT). The clients will award the projects with an agreed completion time, cost, quality and scope of work. The Expert Sector will be appointed by HOPT as the Head of Design Team (HODT) with each disciplines (Architect, Civil & Structure, Geotechnical, Electrical, Mechanical, Quantity Surveyor, etc.) required to fulfil the project's design within the agreed time, cost, quality and scope.

When the scope is given by the client, the architect will start with the concept design and the client is required to approve the concept design before the architect can proceed with the preliminary design. This is provided that the '*confirmed proposed site*', reasonable cost and reasonable time duration has been incorporated in the design. But this has not been the case and HODT's are pressured by the HOPT's to complete the design within a short period of time without beforehand properly completing and finalizing the projects brief. Delay by the client in finalising the architect's concept design has also contributed to the delay and problems of the successive design stage efforts.

The situation above also occurs in the design and build method, which is faced by the consultants, contractors, clients and PWDM's project team. The client needs to provide the project brief to the HOPT within the agreed time, cost, quality and scope. The appointment of HODT is to ensure that the statements of needs are prepared and completed before appointment of any contractors. Contractors are appointed to execute the project, starting from the design stage up until the handover stage (including the defect and liability period). The concept design comes from the HODT's architect to verify that the project is within the agreed cost given by the client. If the project brief, especially the projects scope of work is not completed during the planning stage; the projects concept design and need statement will not be clearly defined.

During the design stage, it is common that the consultants and the contractors do not put serious attention to the design coordination amongst the design

disciplines. It is also a fact that sometimes the HOPT is forced to pressure these parties to complete the design works within a short period of time.

In addition, conventional projects as well as design and build projects also experiences the same problem during the early stage of a project. Whenever the HOPT holds a coordination/technical meeting of projects, the meeting objectives are not agreed or met, even though in the presence of the clients. In certain occasions, roles and responsibilities of HOPT's and HODT's with the clients are not clear resulting in ineffective communication.

Figure 1.2 indicates a flow chart of basic work process in implementing project delivery based on Quality Management System (JKR,2014).

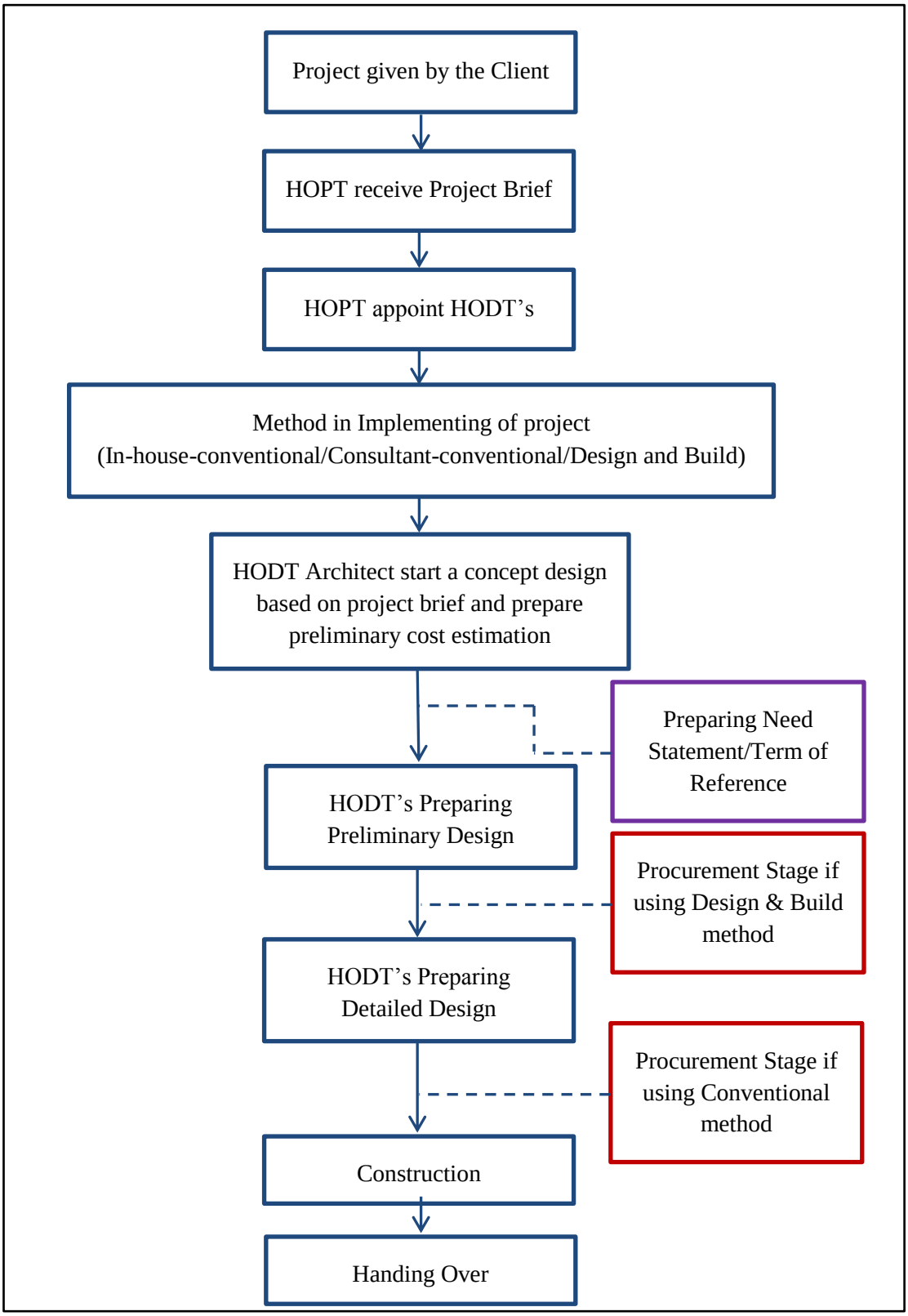

Figure 1.2: Flow Chart of Basic Work Process in Implementing PWDM Project Delivery

In PWDM, conflicts mainly occurs during the construction stage and this will lead to delay in project completion. A study by Mohamud (2013) found that there are

three (3) main factors on each categories of delay that may occur in projects during the planning and design stage. These factors are:

a. Client related
    A. Slowness in decision making process
    B. Change order
    C. Client interference
b. Consultant/Designer
    A. Poor communication and coordination
    B. Poor monitoring and control of progress of work
    C. Errors and discrepancies in design documents

From the study done by Mohamud (2013), it is shown that, one of the important factors in consultant/designer category is errors and discrepancies in design documents that will lead to delay during the construction stage.

Although PWDM has introduced new approaches such as Registered IBS System Provider (RISP) and Problem Solve Governance (PSG), projects are still experiencing delays due to the internal and external problems resulting in improper implementation of the approaches. (JKR, 2014).

1.3 Problem Statement

PWDM is a technical agency that has supervised a vast number of projects which includes the planning stage up until the projects handover. A total number of 810 building projects for RMK9 and RMK10 registered in '*Sistem Kawal Lapor*' in 2013 (SKALA, 2014). On Jun 1st, 2009, Utusan (2009) has reported that 80% of PWDM projects are delayed and this hasleft a negative impression in the public's eye in regards to the organization. Even though all of the projects were completed, there is a major issue in projects completion delay. According to the SKALA report

(2013), an estimation of 57% of projects were delayed from the list of 216 projects which were in the construction phase (Mohamud, 2014).

Several reasons have been identified which had contributed to the delay of projects by researchers (Luh et al., 2006). Some of the delay factors which may be related to this study are:

a. Delays in design works and frequent changes in orders/design (Arditi et al., 1985)
b. Increases in the scope of the work (Semple et al., 1994)
c. Changes of design (Ogunlana et al., 1996)
d. Poor design and changes in orders/design (Al-Monami, 2000)
e. Inadequate early planning of the project (Faridi and El-Sayegh, 2006)

According to Mohamud (2014), the top five (5) most important causes of project delay in PWDM are:

a. Poor site management and supervision
b. Financial difficulties – poor cash flow management
c. Inadequate contractor experience
d. Poor communication and coordination
e. Slow in the decision making process

The purpose of this study is to investigate the effectiveness of applying BIM in managing conflicts during the construction stage. The study area is to focus and locate these conflicts that can potentially contribute to the delay and variation of PWDM projects. It will also emphasize on the lack of coordination within the projects planning and design stages. From the results and findings, we will try to explore BIM's potential in managing these conflicts in order to ensure a more efficient coordination and communication among the project team members and parties. Hence, minimizing conflicts during the construction stage.

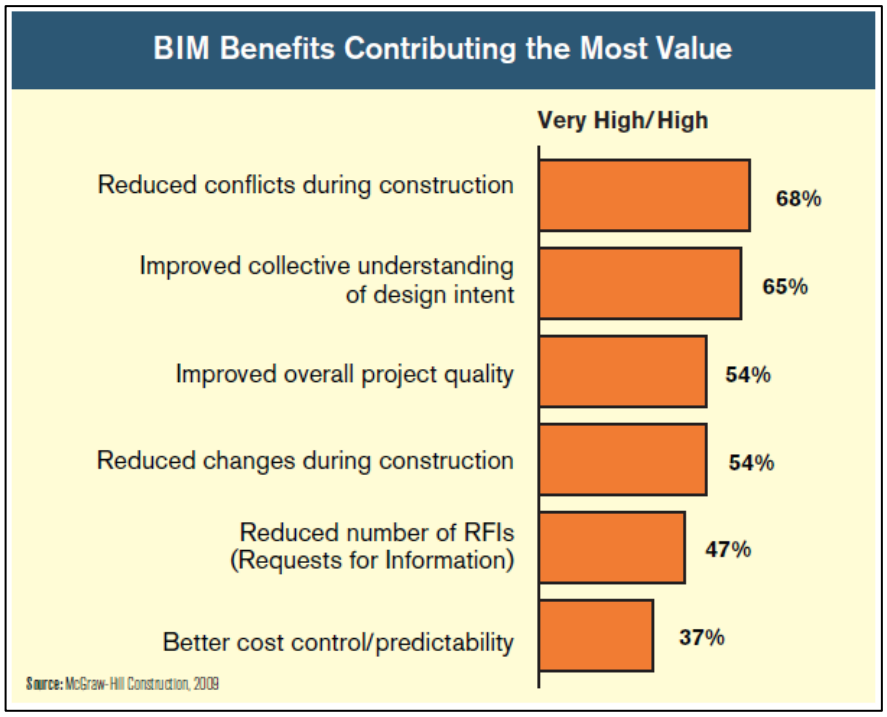

Figure 1.3: BIM Benefits Contributing the Most Value (McGraw Hill, 2009)

Figure 1.3 shows the top benefits contributing the most value to a project, taken from the McGraw Hill (2009). The top benefits of using BIM are:

i. Reduced conflicts during construction
ii. Improved collective understanding of design intent
iii. Improved overall project quality
iv. Reduced changes during construction
v. Reduced number of Request for Information (RFIs)
vi. Better cost control/predictability

The most immediate benefits of utilising BIM in projects is that it produces better designs and increases efficiency and productivity (Batcheler and Preger, 2011). The design and construction documentations are closely linked, and the time to produce these documents have been reduced significantly through the application of BIM. This was achieved by the reduction in time required to evaluate different alternatives thus minimizing the time to execute these design changes. This is particularly important to the clients as it maximize the cumulative benefits of BIM through enhancing the efficiency in project delivery, reducing risks and optimising

client's satisfaction (Batcheler and Preger, 2011). Apart from efficiency and productivity, BIM facilitates to optimize project coordination amongst various disciplines (Autodesk, 2011).

Findings from the study indicates that conflicts will more likely contribute to project delay and variations to PWDM projects. This is due to the lack of efficient and effective project communication and coordination. From the analysis results, conflicts are likely to be reduced by applying BIM as it also helps to ensure a better communication and coordination amongst project stakeholders. Hence, preventing the project from further delays and variations.

1.4 Research Questions

The research questions of this study must be relevant and significant in order to provide solutions to the common problems experienced by the AEC industries and specifically, within PWDM. The questions relevant to this study are:

i. What is conflict in respective to project construction
ii. What are the problems that triggers conflicts during the construction?
iii. What are the factors contributing to delays and variations during construction stage?
iv. Why conflicts occur in projects during construction stage?
v. How to overcome these conflicts which occurs during the construction stage?
vi. What is BIM and how is BIM relevant to projects during the construction stage?
vii. Why use BIM in to reduce conflicts during the construction stage?
viii. How is BIM able to reduce these conflicts?
ix. How to manage the conflicts by applying BIM?
x. Is there any resistance to implement BIM?

1.5 The Aim and Objectives of the Study

The focal objective of this study effort is to investigate the effectiveness of applying BIM in managing conflicts during the construction stage. The study will address the followings:

a. To identify conflicts occurring during construction stage for conventional projects and BIM projects
b. To compare the conflicts between conventional projects and BIM projects
c. To make recommendations on managing conflicts in order to reduce the conflicts related problems

1.6 Scope of Study

The scope of this study is limited to hospital projects that have been delivered by PWDM only. This is due to the reason that up until the year 2014, there was only one project that has been completed which utilises the BIM approach; that is the National Cancer Institute, Putrajaya. The project was awarded as a design and build contract. Therefore, only design and build hospital projects from RMK-9 are comparable to the completed BIM-utilised project. All of the projects data will be gathered from the PWDM database, "Sistem Kawal & Lapor" (SKALA). The data will be gathered and separated into conventional projects and BIM projects. These two group data's will be compared to the variation orders that has been put forward due to the conflicts arising during the construction stage.

1.7 Significance of the Study

The significance of the study is divided into three categories which is aimed at closing the gap between problems in a project environment by minimizing conflicts during the construction stage through the application of BIM.

i. For PWDM

The study of this capstone project is to show that by using BIM tools in PWDM projects, there will be an improvement throughout the PWDM project phases. This improvement will be visible especially in the communication and coordination amongst project team parties which focuses on reducing conflicts during the construction stage.

ii. For PWDM Staff

It is hoped that the study will provide benefits and useful information on the implementation of BIM methodology within PWDM projects and eventually creating greater awareness and readiness when they themselves are actively involved in future BIM related projects.

iii. Significance to Knowledge

The findings of this study would be of interest for those whom are involved directly in BIM and also the construction industry as it extends the current knowledge base for BIM. This is mainly due to its capability in reducing conflicts hence, providing greater benefits to the construction industry. It is also hoped that in the near future, the topic of BIM can be further explored by other researchers.

1.8 Research Structure

This research study, also known as the capstone project will specifically focus on PWDM. The first chapter will briefly discuss about the Introduction, Problem Statement, Research Questions that will provide Aim and Objectives of the research and the scope of the study. Most importantly is the significance of the study towards providing benefits to PWDM and its staff.

Chapter 2 will be the Literature Review which will discuss scholars and academic findings related to this study. The sub-topics for this chapter is:

- Variation and conflicts during construction phase,
- What is BIM?
- Relationship between stakeholder satisfactions by implementing BIM in projects.

Previous study and implementations of BIM within PWDM will also be discussed briefly in this chapter in order to further understand BIM projects and its benefits.

Research Methodology will be covered in Chapter 3. The focus is to provide a step by step guideline for the researcher in order to successfully achieve the aims and objectives of this capstone project. The methodology of this study is firstly kicking off by collecting data and information. Then, secondly the data and information will be analysed by using qualitative and quantitative method of research design. Finally, the recommendations in that has been found through this research study will be proposed in Chapter 4.

Chapter 4 mainly discusses the analysis and results of the study. The analysis and result will be done comprehensively in regards to the conflicts through comparison between conventional projects and BIM projects. Apart from that, the analysis also will be considering the questionnaires taken by the stakeholders especially their experiences in conducting conventional projects and BIM projects.

Furthermore, the discussion of the results and recommendations will be covered in Chapter 5 through the proposal of a strategic canvas in order to minimize the conflicts during construction through the application of BIM.

Last but not least, Chapter 6 will be the conclusion of this study in regards to the initial aims and the objectives whilst also including the limitations of the study.

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