BUILDING INFORMAITON MODELLING READINESS LEVEL FOR GOVERNMENT PROJECT IN MALAYSIA

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ABSTRACT

The Malaysian construction industry has often been associated with low productivity, quality and standards, despite being one of the major sectors contributing to the Gross Domestic Product (GDP) of the country. The Construction Industry Development Board Malaysia (CIDB) highly encourages the adoption of Building Information Modelling (BIM) among the construction stakeholders to improve the overall standards of the Malaysian construction industry. Nevertheless, BIM adoption rate remains low albeit it was introduced about a decade ago. There have been many studies in the literature investigating the benefits of BIM adoption, factors leading to the low BIM adoption rate and perceptions of stakeholders towards the adoption of BIM in the construction industry. However, there is a lack of case studies that report on the adoption level of BIM during project life cycle (i.e., in which phase BIM was adopted, who are the stakeholders commonly use BIM, etc.) in the Malaysian construction. Therefore, this study attempts to fill in the gap by studying the stakeholder that utilise BIM during project life cycle in the Malaysian government project. Additionally, the pros and cons associated with the use of BIM will also be gathered in this study. Lastly, the readiness of BIM adoption will be investigated as well. Data and information will be acquired through qualitative approach towards targeted projects in Klang Valley, Malaysia. It is hopeful that the findings from this real case scenario study

could provide a better insight to the government and/or stakeholder the rooms for improvement in the support from the government in introducing BIM in this industry in order to achieve the goal that has been set by Public Works Department (JKR) Strategic Plan 2021-2025 to achieve 50% BIM adoption rate by next year and 80% by year 2025. This in return, is hopeful to promote greater BIM adoption in the construction industry, which will improve the overall standard and quality of the Malaysian construction industry.

Keywords: Construction Industry in Malaysia; BIM; Adoption Level of BIM in Malaysia; Project Life Cycle

ABSTRAK

Industri pembinaan Malaysia sering dikaitkan dengan produktiviti, kualiti dan standard yang rendah, walaupun merupakan salah satu sektor utama yang menyumbang kepada Keluaran Dalam Negara Kasar (KDNK) negara. Lembaga Pembangunan Industri Pembinaan Malaysia (CIDB) sangat menggalakkan penggunaan Model Maklumat Bangunan (BIM) di antara pihak berkepentingan pembinaan untuk meningkatkan standard keseluruhan industri pembinaan Malaysia. Walaupun begitu, kadar penggunaan BIM tetap rendah walaupun diperkenalkan sekitar satu dekad yang lalu. Terdapat banyak kajian dalam literatur yanh menyelidiki manfaat penggunaan BIM, faktor-faktor yang menyebabkan kadar penggunaan Bim rendah dan persepsi pihak berkepentingan terhadap penerapan BIM dalam industri pembinaan. Walau bagaimanapun, terdapat kekurangan kajian kes yang melaporkan tentang tahap adopsi BIM selama kitaran hayat project (iaitu, di mana fasa BIM diadopsi, yang mana pihak berkepentingan biasanya menggunakan BIM, dll) dalam pembinaan Malaysia. Oleh itu, kajian ini cuba mengisi jurang dengan mengkaji pihak berkepentigan yang menggunakan BIM semasa kitaran hayat projek dalam projek kerajaan Malaysia. Selain itu, kebaikan dan keburukan yang berkaitan dengan penggunaann BIM juga akan dikumpulkan dalam kajian ini. Terakhir, kesediaan penggunaan BIM akan disiasat juga. Data dan maklumat akan diperoleh melalui pendekatan kualitatif terhadap projeck yang disasarkan di Lembah Klang, Malaysia. Diharapkan penemuan dan kajian senario kes ini dapat memberikan wawasan yang lebih baik kepada pemerintah dan / atau pihak berkepentingan untuk meningkatkan dukungan pemerintah dalam memperkenalkan BIM dalam industri ini untuk mencapai tujuan yang telah ditetapkan oleh Pelan Strategik Jabatan Kerja Raya (JKR) 2021-2025 untuk mencapai 50% kadar penggunaan BIM pada tahun ini dan 80% pada tahun 2025. Ini sebagai balasan, diharapkan dapat mempromosikan penggunaan BIM yang lebih besar dalam industri

pembinaan, yang akan meningkatkan keseluruhan standard dan kualiti industri pembinaan Malaysia.

Kata kunci: Industri Pembinaan di Malaysia; BIM; Tahap Penerapan BIM di Malaysia; Kitaran Hayat Projek.

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CHAPTER 1: INTRODUCTION

1.0 Background Study

The construction industry is one of the major sectors contributing to the Gross Domestic Product (GDP) in Malaysia (Raza Ali K., Mohd Shahir L. and Ghazali B.Z., 2014). Despite being a major contributor to the economy, the Malaysian construction industry is often associated with low productivity, quality and standards. Generally, a construction project involves many stages of planning and execution, which can be clearly seen from a project life cycle given in Figure 1. It involves many stakeholders from different professions throughout the whole construction process from defining the project to project handover (Karlsen J.T., 2015). Hence, Building Information Modelling (BIM) has been introduced to increase the effectiveness and productivity of the construction industry (Ahmad Latiff A., Brahim J. and Fathi M.S., 2017).

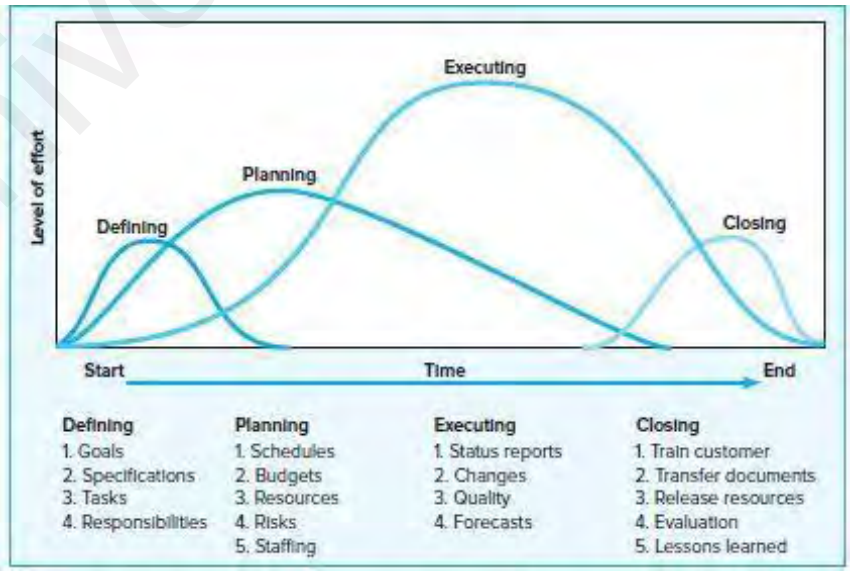

Figure 1.1: Project Life Cycle
(Karlsen J.T., 2015)

BIM is an advanced tool that aims to improve the performance and productivity of the stakeholders in a construction project, particularly those from the Architectural, Engineering and Construction (AEC) industry in generating and managing project information throughout the project life cycle (Ahmad Latiffi et al.,2013). Additionally, the adoption of BIM can enhance the communication and collaboration among construction players as well. It can generally be concluded that BIM is a suitable method to increase profit and value of construction projects.

Nevertheless, the adoption rate of BIM in Malaysia is still far from expectation, since its introduction nearly a decade ago. A survey conducted by the Construction Industry Development Board Malaysia (CIDB) (Malaysia Building Information Modeling Report, 2016) revealed that among the 570 respondents, there are only 17% of them are BIM adopters. The reasons for the low adoption rate were precluded to be 1) lack of clear policies, 2) insufficient financial incentive, and the 3) failure to invest in BIM training, BIM hardware and software, and etc. From the report, it was indicated that the ineffectiveness and low productivity of the construction industry are partially attributed to the limited adoption of new technologies and practices.

1.1 Problem Statement

Information, Communication and Technology (ICT) has been recognized as one of the main tools to stimulate the overall performance of construction industry in Malaysia. (Ahmad, 2013) and BIM is part of ICT. Government has put a lot of effort to raise the

awareness of industry practitioners to realise the benefits of implementing such technology in hoping that the implementation rate can be increased that lead to the improvement of performance of construction industry. One of the efforts includes implement BIM in the public project, The National Cancer Institute (NCI) that located in Putrajaya which acts as the pilot project to proves the benefits of using BIM to be public (Harris et al., 2014). Results showing BIM able to shortened the construction period which project NCI was completed three weeks earlier than projected completion date and ease problem-solving at the early stage of project lifecycle (Harris et. al., 2014). Since then, Malaysian Public Work Department (PWD) has accepted BIM which aims to introduce BIM on 10% of public projects that cost above RM50 million under Rancangan Malaysia ke-11 (RMK11). Currently, Malaysian Ministry has scheduled the mechanism's adoption to hit 50% this year and 80% by year 2025 through PWD Strategic Plan 2021-2025.

However, even there are many initiatives that were conducted by Malaysian Government strategically to embrace the benefits of BIM, the implementation rate still relatively low across the construction industry. According to Latffi et al. (2016) and cited by Brahim (2018) and Yusoff et al. (2021), most of the construction practitioner in Malaysia implement BIM with the main purpose for 3D visualization, clash detection, cost estimation and design review which is mostly at the design stage but limited use in the construction and operation stage. This fragmentation causes the delay of application of BIM which lead to the consequences of keeping the industry in low level of implementation. there are many reasons cause the fragmentation happens which includes lack of understanding the BIM implementation process, lack of experience in preparing BIM plan and the capability to utilise it with stakeholder, lack

of coordination and collaboration among various disciplines, lack of proper guidelines, reluctancy to change the current practices and so on (Othman et al., 2021). Meanwhile, according to Jaafaar et al. (2007) the technology readiness index (TRI) scored a moderate among the managers of Malaysian contractors with no significant difference between bigger firms and smaller firms.

Nonetheless, improper implementation planning for new technology often leads to a consequences of construction practitioners unable fully utilise and gain benefits from such technology where most of the companies invest in technology advancement without conducting feasibility studies prior implementation. This is due to majority of them simply follow others that successfully adopt and implement such technology. Hence, they are not aware of the needs and potential problems that may arises and right strategies to tackle with (Ahmad, 2013). On top of that, the nature of ICT that change rapidly leads to most of the companies failed to adopt in term of technologies, processes, expertise and practices within their organisation. Meanwhile, according to Alshawi (2007) and Peppard (2007) saying that the company required sometime to gain benefits from the investment in ICT. This is because ICT required some time to mature and evolve in the existing practices within the organisation, therefore, there is a time gap between the early investment and earning.

For BIM, it required a strategies planning for the implementation considerate review on many aspects but most importantly, the readiness of implementation within the organisation need to be assessed. Smith and Tardif (2009) pinpoint that organisational's readiness is essential to be assessed prior the adoption and implementation to realise the real value for such investment. The intention to assess the readiness level of the

organisation is to measure the current position of the organisation and the gap to reach the fundamental implementation requirements for such technology and the implementation requirement refer as readiness criteria (Ahmad, 2007). However, there is a lack of case studies that report on the stakeholder that utilize BIM throughout project lifecycle for government project as well as their benefits and challenges that encountered during the adoption as well as the level of readiness of BIM adoption in government project. Therefore, this research aim to fill up the gap through using the readiness criteria that framed out by Ahmad (2013) which covers the elements of people, process, technology and management.

1.2 Research Questions

1. Who is the stakeholder that utilize BIM throughout project lifecycle for government project?
2. Who are the benefits for adopting BIM in the construction processes for government project?
3. What are the challenges encountered for adopting BIM in the construction processes for government project?
4. What is the level of readiness in adoption of BIM throughout project lifecycle for government project?

1.3 Aims and Objectives

This study aims to investigate the readiness in adoption of BIM throughout project lifecycle for government project. The following objectives are laid out in order to

achieve the aim of this study.

1. To identify the stakeholder that utilize BIM throughout project lifecycle for government project

2. To identify the benefits for adopting BIM in the construction processes for government project

3. To identify the challenges encountered for adopting BIM in the construction processes for government project

4. To investigate the level of readiness in adoption of BIM throughout project lifecycle for government project

1.4 Research Methodology

Information and data required in this study will be gathered via interview sessions. A brief overflow of this research study is given in Figure 2.

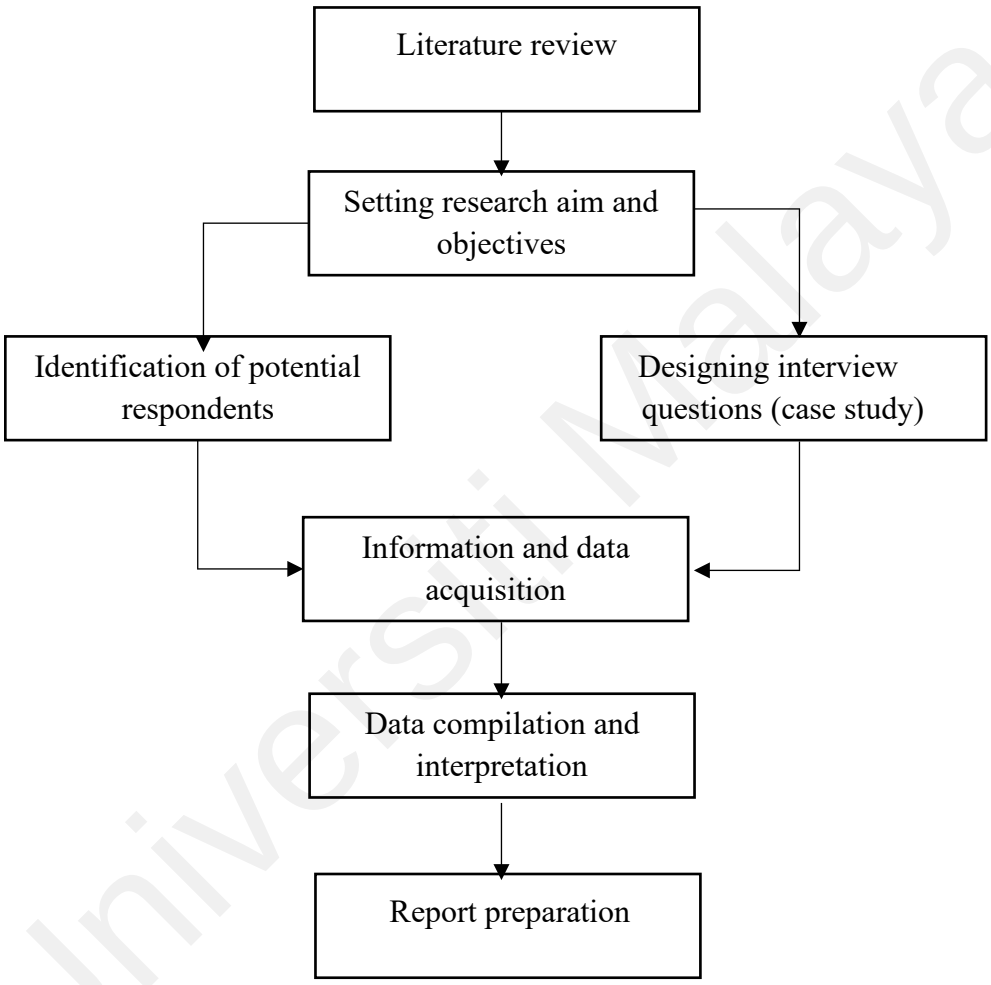

Figure 1.2: Brief overflow of this study

1.5 Scope and Limitations

This study attempts to highlight and study BIM adoption level during project life cycle for government project in the Malaysian construction industry. Information required in this study will be acquired from government agencies of the construction project via qualitative approach (virtual interview). However, due to time limitation, this study is limited to projects in Klang Valley, Malaysia only and also only involve one of the stakeholder's company in this research project. On top of that, due to the outbreak of covid-19 pandemic, only virtual interview can be conducted, other methodology like observation unable to carry out within the organisation. To achieve the objectives of this study, the following process are identified.

1. Designing interview questions to gather information from developers
2. Defining qualitative measures (i.e., the percentages of cost and time savings, return of investment, etc.) to analyze the findings
3. Compiling, consolidating and interpreting the information and data gathered from the interview sessions

1.6 Research Significance

This study could provide a better insight to the government the rooms for improvement in the support from the government in introducing BIM in this industry in order to achieve the goal that been set by Public Works Department (JKR) Strategic Plan 2021-2025 to achieve 50% adoption by next year and 80% by year 2025. This in return, will help in promoting BIM adoption in the construction industry, which will improve the

overall standard and quality of the Malaysian construction industry.

CHAPTER 2: LITERATURE REVIEW

2.0 A review of Malaysian Building Information Modelling (BIM) adoption

Building Information Modelling (BIM) which also known as virtual prototyping technology or n-D Modeling that provide visualization of what is going to build, analyse potential design problem, construction or operation issues throughout the project life cycle (Azhar et al., 2012). Besides, it helps to improve the performance and productivity of the stakeholders in a construction project, particularly those from the Architectural, Engineering and Construction (AEC) industry in generating and managing project information throughout the project life cycle (Ahmad Latiffi et al.,2013). Additionally, the adoption of BIM can enhance the communication and collaboration among construction players as well. It can generally be concluded that BIM is a suitable method to increase profit and value of construction projects.

Nevertheless, the adoption rate of BIM in Malaysia is still far from expectation since its introduction nearly a decade ago. A survey conducted by the Construction Industry Development Board Malaysia (CIDB) (Malaysia Building Information Modeling Report, 2016) revealed that among the 570 respondents, there are only 17% of them are BIM adopters. According to Memon et al. (2014), the absent of awareness is the reason of low adoption in Malaysia. Besides, the attitude of reluctancy to change by industry player is one of the reasons where they see this as a "troublesome technology" that bring problems when transforming from the established technology that currently adopting (Eastman et. al., 2011). Hence, ministry has set the adoption of rate to reach

50% by 2021 and 80% by the year 2025 through Public Works Department (JKR) Strategic Plan 2021 – 2025 (The Malaysian Reserve, 2020). In addition, according to Minister Datuk Seri Fadilah Yusof the ministry will ensure 50% of the projects that worth RM10 million and above will adopt BIM mechanism and reach a 10% increment in the subsequent years before 2025. Hence, government play a leading role in encouraging BIM implementation where public sector is the main client that has the strongest power of promotion (Azhar et. al., 2012).

2.1 BIM application for stakeholders during Project Life Cycle

Generally, a construction project involves many phases, from defining phase to post-construction and operational phase or some even to the extent of demolition phase and involved a lot of stakeholders throughout the phases. With the involvement of BIM, it is believed that communication and interaction between stakeholder can be improved so that conflict can be reduced, waste reduction and enhance productivity and efficiency throughout all the phases etc. (Azhar et al., 2012; Zahrizan et. al., 2013)

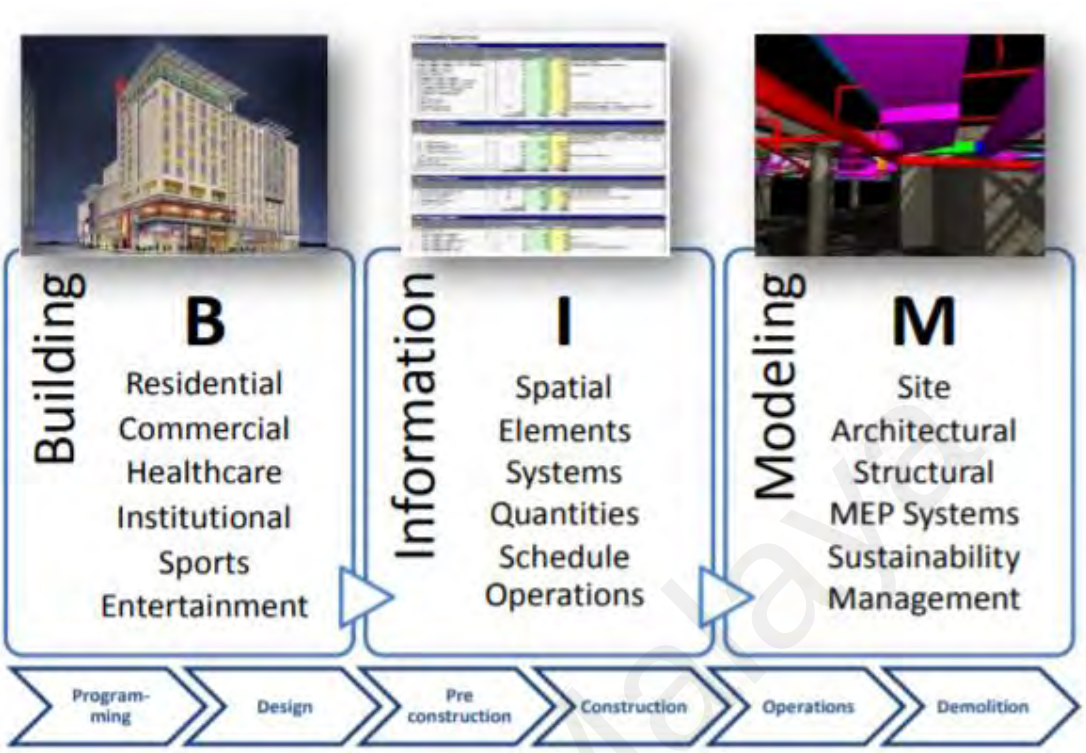

Figure 2.1: BIM Concept during the project lifecycle (Azhar et. al., 2012)

The adoption of BIM in the programming phase allows project team to have a clearer picture in analysing and understanding the complexity of space standards and land regulations. Hence more time can be saved and spend on other activities that add value to the project. Besides, it also able to aid the project planner in site selection and conduct the feasibility study and market survey. The advancement of 3D laser scanning that allow practitioners scan and have a visualization of the existing utilities through integration with BIM. This greatly benefits the practitioners in planning especially for renovation works (Azhar et. al., 2012).

During the design phase, project owner (which is the client), architects, mechanical and structural engineers able to gain benefits from BIM application. For instance, the most

appropriate building layout in term of best fits of purpose and economical can be selected during the schematic design stage and able to have a better vision and imagination on the detailed design and construction detailing through providing a 3D visualization walk-through. While in the pre-construction phase, a more accurate cost estimation can be prepared by quantity surveyors while at the same time reduced a lot of time for preparing it through the application of BIM (Othman et. al., 2020) where the financial risk that faced by the project owner can be lower because of the more accurate and reliable estimation. Moreover, traffic layouts, site logistic and potential hazards at the construction site can be identified, planned and developed earlier by the contractors through 3D/4D site coordination models where it can also assist in site safety plan preparation. Besides, a sequence of operation at site can be planned through detailed constructability analysis from BIM models.

In construction phase, 5D BIM can be used in monitoring the actual spend compare with the budgeted cost through a regular cost reporting (McPartland, 2017). Cost manager will be able to be notified when there are changes made and shared within the Common Data Environment. Besides, the project team can use BIM to monitor work progress using the 4D BIM plan through integration with tablet and smartphone technology that allow them to extract information anytime and anywhere. Hence, a continuous updating of latest information is crucial in other to obtain the most reliable data that up to date. Moreover, the latest information shared also can be used for operation and maintenance by facility manager during the post-construction phase through 6D BIM. 6D BIM support the operation and maintenance through provide information such as component manufactured, the date of installation and date of maintenance and so on where this will increase the efficiency and prevent unnecessary

losses.

2.2 BIM Benefits

The benefits of BIM shall be mentioned as it a motivation for organization to implement BIM. Back in year 2007 where Kaner researcher found that many of the organisation encountered issue such as drafting error due to the complexity of design with CAD system and it happens frequently among the construction industry and eventually led to a consequence of low productivity and low cycle times for design review within the organization. In order to overcome such issues, it is essential for the organisation to understand thoroughly on BIM benefits where the organization can optimise it through strategizing their action plan that associate with their business needs. For this research, it is crucial for the author to understand the benefits of BIM where it can assist in understanding the principle and the context of BIM implementation for the organization which it may impose different standard in the organisation's capability.

BIM is an innovative technology that aids in add value to deliver the construction domains throughout the project life cycle from the conceptual stage to operation and or demolition stage (He et. al., 2017). Numerous researchers identified the significant benefits of BIM adoption and implementation to increase the efficiency and productivity of the project team. BIM has the ability to integrate time and cost which supports real-time update and assess efficient tracking and monitoring process along the project phases (Scheer et. al., 2014; Jrade A. et. l., 2015). Besides, it able to detect clashes due to design error and optimize it. Moreover, BIM acts as a platform that share the latest design and information to all the stakeholders more efficiently and able to

assist in making a more precise decision especially when there's problem arises (Palos, 2012).

Besides, BIM able to enhance the communication between all the parties involved and maintain synchronization between them so that conflicts can be reduced. Next, time-based clashes can be identified and integration of construction scheduling and planning can be done through the application of BIM (Al-Ashmori et al., 2020). However, even it required early involvement of stakeholder at the early stage that will increase the upfront cost for BIM implementation, it is proven that the overall construction cost will decrease variation orders and delay can be reduced and avoided (Hanon, 2007).

A great reduction of rework is proven to be one of the major benefits of BIM implementation during the construction (Aranda-Mena et. al., 2009). Not only that, but BIM model can also greatly contribute to facility manager through providing information such as specification of manufactured components, the date of installation and date of maintenance so that on-site survey before any renovation or maintenance works can be mitigated (Talebi, 2014).

2.3 BIM Challenges

Besides plenty of benefits of BIM application, there are challenges do exist either during or after its adoption. Interoperability been identified as one of the major benefits which as a platform to exchange information on the latest up to date information from one software/computer system to another without losing one. However, one of the biggest challenges which also comes from the interoperability is the lack of

standardization of model integration and management by multidisciplinary teams. Integration of multidisciplinary information in a BIM model necessitate multiple user access to the same model and this requires the same protocol to be used during the programming phase. However, there is no standardize protocol exists yet so each firm comes out with its own standard and could at the end lead to inconsistency in the model (Azhar et. al., 2012). Besides, the existence of multiple software vendors in the market nowadays offer different type of software hence increase the possibility that the software is not compatible with each other among the project team unless the same one been adopted.

Apart from that, there is also possibility that project stakeholders are unfamiliar with its functions or unaware of the protocols about the information transferred which make the software interoperability does not fit its purpose (Migilinskasa et. al., 2013). Hence, training or hiring of employee that familiar with BIM or the software associate with it is necessary and this will directly influence the productivity of the organization (Tulenheim, 2015). Moreover, the constant training that needed seem unlikely especially for smaller or new firms in term of time and money. Thereby, will make the organization step backwards from BIM adoption (Migilinskasa et. al., 2013).

In addition, another potential challenge is the authority to edit the model among the stakeholders. When multiple stakeholders are expected to be involved in developing of BIM model, it is hardly to ensure there is no mistake especially when there are multiple of stakeholders editing or developing the same model constantly. On top of that, challenges such as copyright of the design and BIM data will be another challenge as well.

2.4 Readiness assessment of BIM adoption

This subchapter will discuss about the readiness assessment which align with the objective 4 – to investigate the level of readiness in adoption of BIM throughout the project lifecycle.

Besides, the aim of achievement of objective 4 is to explore, assess and combine concept, readiness model and its component that currently available. The available readiness component is important and relevant to this research as it forms a guide for the author in developing interview questions which is the data collection methodology for this research

2.4.1 Concept of Readiness Assessment

According to Alshawi (2007), generally the readiness assessment be done in Information Technology (IT) application which as a measuring tool to assess the readiness gap of the organization prior to IT investment. It is to identify the organisation's current capability compared with desired level that the company wants to achieve. On the other hand, Ruikar (2005) defined that organisation's capability can be evaluated through e-evaluation in term of the adoption, usage and benefits from information and communication technologies (ICT). Meanwhile Taylor (2003) defined the readiness as measure of the capability of citizen and businesses to adopt and use electronic services (e-services) such as online banking.

However, to have a better understanding on the readiness concept, according to Kangas (1999) and Moingeon et. al. (1998), strategic application of competencies is referring to organisational capability while according to Amit and Schoemaker (1993), the definition of competency is the capacity and ability of an organisation to utilize resources to achieve specific objectives. The definition of organisational capability further discussed by Alshawi (2007) saying that organisaitonal capability being built through the process of development and deployment of specific organisational competencies. Hence, competency is therefore being described as the capability to utilise specific organisational resources to complete an assigned task (Teece et. al., 1997; McGrath et. al., 1995). In addition, competency is then being treated as representation of collective knowledge of the firm in commencing or reacting to specific change that is built into the organisation's processes, procedure and system.

According to Saleh and Alshawi (2003), it is necessary to assess the capability in term of processes, work environment and structure so that a productive decision can be made in other to achieve such capability especially comes with the decision to implement specific ICT system within the organisation. Meanwhile such assessment should be carried out on the capabilities in the relevant areas that have the possibility to impact the development of the required ICT capabilities. On top of that, prediction should take place as well on required level of change along with the associated resources to develop the desired capabilities. Table 1 below shows the theoretical framework which proposed by Haron (2013). It consists of four elements and each of it consists of respective categories. According to Smith and Tardif (2009), in order to implement successfully a new technology, management buy-in and belief is necessary as well as policies and strategies. Not only that, leadership and management playing a crucial

factor which affecting the implementation of BIM where the implementation requires a full support from the top management. Hence, the elements in the table 1 below will be assist in investigating the readiness of the BIM adoption.

Table 2.1: Theoretical framework to explore BIM readiness criteria (Ahmad, 2013).

ELEMENTS	CATEGORY	READINESS CRITERIA (to explore...)
PROCESS	PROCESS CHANGE STRATEGY	The degree to which an organisation has developed a documented methodology for changing its business process
	BIM IMPLEMENTATION MANAGEMENT	The presence of good management practice to incorporate BIM within the business process
	POLICY	The suitability of current contract and project delivery method for BIM use
MANAGEMENT	BUSINESS STRATEGY	The formulation of business strategy which identifies the most advantageous uses of BIM
	MANAGEMENT COMPETENCY	The management competency and support on the use and implementation of BIM
	LEADERSHIP	The management leadership to drive BIM implementation
PEOPLE	ROLES AND RESPONSIBILITY	The creation and justification of BIM associated roles and responsibility by the organisation
	SKILL AND ATTITUDE	The skill and attitude set that is required by the staff to implement BIM
	TRAINING AND EDUCATION	The educational/training program and deliverables to support the BIM implementation
	WORK ENVIRONMENT	The characteristics of good work environment to support BIM implementation
TECHNOLOGY	HARDWARE	The ICT hardware tools and infrastructure to implement BIM
	TECHNICAL SUPPORT	The software and hardware technical support to assist BIM implementation
	SOFTWARE	The type of software use and the justification of selecting the software

2.5 Summary of Literature Review

The main objective for this study is to investigate the readiness of BIM adoption during the project lifecycle for government project in Malaysia. However, before this, the construction project lifecycle in associate with BIM implementation been identified as programming, design, pre-construction, construction, operation and demolition with the use of 3D to 6D BIM model. Stakeholder that involve during the project lifecycle includes, owner, contractors, consultant (engineers, quantity surveyor, architecture and designer) and facility manager. Nonetheless, the benefits of adopting BIM includes, increase the efficiency and productivity of the project team, integrate time and cost which supports real-time update and assess efficient tracking and monitoring process along the project phases, to detect clashes, a platform that share the latest design and information, enhance communication and maintain synchronisation, reduce conflicts, integration of construction scheduling and planning, decrease variation orders and delay. However, despite plenty of benefits been identified by numerous researcher, there are multiple of challenges during the implementation such as lack of standardization of model integration and management by multidisciplinary teams, inconsistency of model due to absent of standardize protocol, incompatible of software due to adoption of different type of software among project team, constant training will influence the productivity of project team and amount of money needed and legal, contractual issue such as copyright. Lastly, to assess the level of readiness of BIM adoption, the assessment criteria been identified which is the four main element, process, management, people and technology.

CHAPTER 3: RESEARCH METHODOLOGY

3.0 Introduction

In this chapter, research methodologies that is used by present researchers and scholar will be discuss in order to carry out the research paper and thus, obtained the research objectives. The methodologies that chosen should be able to help researcher in terms of obtaining data, collecting data, data analysis and research presentation as well.

3.1 Types of Research Methodology

Primary data and secondary data are two types of data classification for all the data collected from the research (Kothari, 2004). Primary data is very crucial for the research as the information obtained are not published and it is derived from a new research of study. The source of primary data would be the questionnaire obtained directly from the targeted respondents.

Secondary data is obtained by someone else without the same purpose. Journal articles, magazine, books are some examples of secondary data that have been used by researchers (Kumar, 2010).

Basically, there are qualitative and quantitative and mixed method of research methodology in order to carry out research (Creswell, 2012). According to Richard and Arita (2008), quantitative research is carried out to study the relationships between facts and the relationships between the theories and the findings of the research conducted previously and the approaches tend to relate to positivism and seek to gather factual data statistical (Creswell, 2008). One of the examples of quantitative approach would be questionnaire survey.

Qualitative research in methodology would be an approach which is used to obtain the opinion and understanding of the people regarding the perception of "the world". Individually or groups. The data collected may be more flexible, that is will tend to be more elaborately and detailed, and hence 'rich' in content and scope. Subsequently, the qualitative methods tend to be considerably more complex and less formal in quantitative research (Richard and Arita, 2008). Life history accounts, observations, discussion and interviews are example of qualitative data (Wilkinson, 2000).

For the purpose of this study, case study (qualitative method) is chosen as a core method used in order to obtain data to achieve the objective of the research which is:

3.1.1 To identify the stakeholder that utilize BIM throughout project lifecycle for government project

3.1.2 To identify the benefits for adopting BIM in the construction processes for government project

3.1.3 To identify the challenges encountered for adopting BIM in the construction processes for government project

3.1.4 To investigate the level of readiness in adoption of BIM throughout project lifecycle for government project

3.2 Research Methodology

In this study, information and data required will be gathered via interview sessions. A brief overflow of this research study is given in Figure 1.2 in Chapter 1.

3.3 Define Research Problem

Identifying the research problem will be the first step ever in conducting the research. According to the Kerlinger, “a problem is an interrogative sentence or statement that asks what relation exists between two or more variable”. Therefore, this study is about identify the stakeholder that adopt BIM during project lifecycle. Through the adoption what is the benefits and challenges that faced and to investigate the readiness of the adoption of BIM for government project where government serve as the biggest client that have the highest power of influences. This hopefully able to provide an insight to government so that a better action plan can take place in order to achieve the target that set during the five-year strategic plan 2021-2025.

3.4 Literature Review

Literature review is one of the most essential stages in a research study as it act as the summary of the relevant review of published and unpublished work from secondary sources of data in order to identify the stakeholder, benefits and challenges from adopting BIM and the criteria of assess the readiness of BIM adoption for government project.

The aim of the literature review is to make sure every single variable in the research not being ignored and gather all the information about the variables from other authors.

For this study, one chapter of literature review included which is about the review of

BIM adoption in Malaysia, construction project lifecycle that includes the implementation of BIM, stakeholders that utilize BIM during the project lifecycle, benefits and challenges from BIM adoption and criteria of assessing BIM readiness for government project.

3.5 Validity and Reliability of the Survey

The potential weaknesses of the case study research are a problem of accessibility, lack of rigour, sloppiness, biased view and lack of scientific basis for statistical generalization. The case study methodology usually faces validity and reliability issues. Validity in qualitative research often verified through findings from researchers (Gibb, 2007). On the other hand, reliability refer to the consistency of researcher's approach across different targeted project.

CHAPTER 4: FINDINGS FROM CASE STUDY

4.0 Introduction

This chapter discusses the case study findings for the achievement of the research objectives that being identified in chapter 1. However, the term 'readiness criteria' used in this research is develop based on the organizational requirement for BIM implementation while the detailed discussion about the concept of readiness can be found in chapter 2. A company that has been involved in government project is chosen for this case study. The company is based in Malaysia and the findings of the case study obtained through physical documentations regarding BIM and face to face interview with key person in the company.

The interview starts with the discussion of the stakeholders that utilise BIM during project lifecycle and the benefits and challenges from implementing BIM. Identification and discussion on readiness criteria of BIM implementation on the company discussed in the later part. The main focus of this case study is on the identified elements of readiness criteria which was identified earlier in the literature review as following:

1. Process

a. Process Change Strategy

b. BIM Implementation Management

c. Policy

2. Management

a. Business Strategy

b. Management Competency

c. Leadership

3. People

a. Roles and Responsibility

b. Skills and Attitude

c. Training and Education

d. Work Environment

4. Technology

a. Hardware

b. Technical Support

c. Software

4.1 Case Study Findings for Company A

Data that obtained through virtual interview with company A will be discussed in this subchapter starting with background of the company, current status of BIM implementation, stakeholders that utilise BIM during project life-cycle, the benefits obtained, and challenges encountered when implementing BIM, and finally will discuss about the readiness level based on the readiness criteria that were identified earlier.

4.1.1 Background of Company A

Company A is government-linked company that involve in property development, engineering, environment and construction and facilities management which its main corporate office located in Kuala Lumpur. It not only involves in building complex structure and infrastructure but also power transmission grids. Besides, they also in charge of rehabilitation and flood mitigation of rivers and coastal areas.

Company A has over 30 years of experiences in the construction industry and been involved in numerous public complex project such as KL Sentral, refurbishment of Bukit Jalil National Stadium etc. Besides, it also involved in an ongoing government project in Brickfield, Kuala Lumpur that targeted to be complete in year 2022. Hence, author targeted company A for this case study which is to identify the readiness level of BIM implementation for government project. List of interviewees that participated in the case study is illustrated in table 2 below:

Table 4.1: Profile of interviewees and their experiences

Name	Department	Designation	Experience (years)
R1	Quantity Surveyor	Assistant Manager	More than 6 years
R2	Quantity Surveyor	Project Manager	More than 20 years

R3	BIM team	BIM Director	More than 10 years
R4	BIM team	BIM Manager	More than 10 years

Table 4.1 shows the interviewee's information who participated in the interview for this research project. All these interviewees are the stakeholders that involved directly in the government project mentioned earlier. Showing that 75% of them has more than 10 years' working experience in the industry. Hence, it is legitimate to infer those interviewees have a broad range of knowledge and experience in the industry where the information provided are reliable.

4.1.2 Stakeholders that utilize BIM during the project life-cycle

Before the discussion of the whole research take place, it is important to identify the roles of the company in the project. Take the Company A on-going project with the government at Brickfield as the case study for this research, stakeholders involved are listed as below:

1. Developer
2. Client
3. Land Surveyor
4. Mechanical & Electrical Engineering

5. Designer
6. Architecture
7. Quantity Surveyor
8. Contractor

However, Company A playing the roles as contractor for the project. Since the project now in the status of under construction, hence, according to R1 and R2, all the identified stakeholder utilised BIM throughout project life-cycle up to construction stage. However, the platform or the type of the software they are using might be different from each other. Hence, the copies of the drawing sent from another either may be unable to display in receiver's devices or not shared in the same platform.

4.1.3 The Benefits of BIM

The company received numerous benefits from implementing BIM. The benefits include better communication between the team member, consistency in keeping team member get the latest information and time saving. A detailed discussion on the benefits will be discussed as below.

4.1.3.1 Better communication among team members

All the respondents have reached a consensus that the implementation of BIM brings the significant benefits in better communication through provides visualization of what is designed that going to build by 3D modelling tools. It not only benefits within inter-team member of the company but towards outside of the company member. This can

reduce miscommunication among the members.

4.1.3.2 Consistency in keeping team member get the latest information

According to R3 and R4, Company A using a BIM platform named ShareBIM where all the members in the organization will share and update relevant information accordingly in the platform. This can ensure that the team members will excess to the latest files whenever there are amendment made by another member within the team. In previous CAD based process flow, it is sometimes confusing on which files is the latest when receive files from other member either within or outside the organization based on R1 and R2.

"...some people would even miss out the amendment made or in another word being not aware of the update. Hence, they are not in par when having meeting and yet it will cause a waste of time when you have to spare time to tell them what is the latest..."

4.1.3.3 Time saving

During the CAD-based process flows, the huge number of drawings generated for a single project has made the clash detection on the design a time-consuming process in manual approach.

"...this is where we spent the most time at in checking all the documentation..."

Respondent 2

According to R2 when he recalls his old style of doing. However, things changed after

the implementation of BIM. Design errors that caused by the inconsistent of drawing is no longer exist since 3D model is the source for all drawings. Besides, clash checking process as well and material take off can be done automatically through using the software which can shorten the period of time in doing it compared with CAD-based process. In overall, the duration spent for documentation, checking and material take off is reduced significantly where people can spare and have more time to focus on other more important aspect.

4.1.4 Challenges of BIM implementation

Company A has faces numerous challenges that arises from the implementation of BIM in the early stage. The main challenges that responded by R2 were reluctant to change by senior staff, interoperability issues of software and negative perception towards new technology. A detailed discussion on challenges will be discussed in the following subchapter.

4.1.4.1 Reluctant to change by senior staff

As mentioned by respondent R2, the biggest challenge that the company encountered during the early implementation of BIM is the attitude of reluctancy to change by the senior staff and the condition get worsen when one of them is come from the middle management level. All the respondents agreed that support from the staff especially those holding management post is playing a crucial role in influencing the attitude of subordinates and people around to accept the changes. People's behavior in willingly staying in comfort zone rather than move forwards in the elderly age makes them

reluctant to learn new thing.

4.1.4.2 Interoperability issues of software

During the early stage of implementation of BIM where software is created by different companies in different disciplines, issues such as failure integration occurred. Company A has adopted BIM software from a software vendor. However, due to the immature of BIM software at the early year where software is created by different companies in different disciplines, interoperability issues encountered especially in data transferring such as receiver unable to open the sent softcopy of drawing from sender among the project team. Therefore, Company A later comes out with the initiatives to resolve the issues through meeting up with stakeholder to discuss on how to solve the problem. The solution is requesting the particular stakeholder to upgrade its existing BIM software since majority of the stakeholder able to integrate probably with the BIM software within their organisation.

4.1.4.3 Negative perception towards new technology

A lot of people in the company were not convinced by the benefits that BIM could offer either directly or indirectly during the early stage implementation of BIM even though some of the BIM awareness programs been organised. The problem get even worst when people make a lot of mistakes during learning and delivery process which will slow down the efficiency and performance of the staff and hence, will directly or indirectly influence the project duration.

4.1.5 BIM Readiness Criteria

In this subchapter, readiness criteria of company will be discussed accordingly following the elements that were identified in chapter 2 and categories each of the readiness criterion belong to.

4.1.5.1 Process

Table 4.2: Readiness criteria for process element

PROCESS ELEMENT	
READINESS CATEGORY	**READINESS CRITERIA**
PROCESS CHANGE STRATEGY	Small and Incremental Approach Process Flow Redesign Incentive and Reward
IMPLEMENTATION MANAGEMENT	Plan Implementation Adequate Resources Pilot Project BIM CAD Coordination
POLICY	Design and Build Contract Amendment

Table 4.2 summarises the readiness criterion for process element that was identified through the interview. The following subchapter will discuss further the nine readiness criteria that was obtained from qualitative data.

4.1.5.1.1 Process Change Strategy

All the respondents agreed that a process flow redesign is required in BIM implementation. It is because since BIM is focus in developing 3D modelling where the 3D model is the main deliverable, an extra development phase shall be developed and incorporated within the current practice. In CAD-based process flow where drawing, specifications and Bill of Quantity is the main deliverables where all these information are created individually but not extracted from the model like BIM.

On top of that, according to Interviewee R3 & R4, BIM offers plenty of benefits through engaging varies application. However, grab them all in once is something impossible. Hence, the company has engaged a stage-by-stage approach by dividing the BIM implementation into small technology application where the implementation must be tied with long-term investment that distributed into a series of small milestones. Meanwhile, on the technology application aspect, product library will be developed first and authoring 3D model to satisfy the main needs of clash detection by the company when implementing BIM. Once the drafter and BIM administrator satisfied with it, then other related deliverables such as drawing extraction and coordination, material take off etc. will be explored. According to respondent R3, company has set the BIM implementation as standard operation procedure is a midterm planning while collaboration with other business partner in BIM models treated as a long-term plan.

Respondent R3 supported the stage-to-stage approach that set by the company where everyone required some times to master a new skill while delivering their job responsibility at the same time, evidenced in the following statement:

> *"…In order to master a new skill or get used to a new software, times and effort is necessary for everyone no matter what position you are located in the hierarchy. It is totally normal when a new software been purchased. It is similar to a human being where we started with crawl first, then stand and walk before we start to run. All these happened in stages as well where each stage requires some times to master it…"* Interviewee R3.

Last but not least, the readiness criteria that was identified in the company is incentive and rewards. Most of the incentive and rewards are in monetary, working leave entitlement or new wage scheme, however, it was not evidenced within the company. According to interviewee R3 and R4, the competency of roles as designer or administrator in carrying the Revit Structure is considered as one of the main criteria adopted by the company to consider the wage increment and promote the senior post which aligns with the company policy regarding continuous improvement and the application of the most advanced information technology. On top of that, interviewee R4 said that, chance given to learn a new thing or new skill is considered as a non-monetise rewards, as evidenced in the following statement:

> *"…To me, an opportunity to learn a new thing is much important that monetary incentive where I can put in extra skills that I master in in my resume, which added my value indirectly. Sooner or later the company will*

increase our salary or grant a promotion along with the increase of my market value…" Interviewee R4

4.1.5.1.2 BIM Implementation Management

A;l the respondents agreed that a proper BIM implementation plan is considered as essential readiness criterion to stimulate the implementation. However, author is not granted permission to look at the documents where the company do have documented the implementation plan in softcopy. Basically, the implementation plan that developed was aligned with company's policy, mission and vision which support the operation and business nature of the company.

Besides, resources sufficiency also is one of the essential criteria for the company. The evidence suggests that, lot of the activities are not possible to carry out without sufficient number of resources. Some of the activities that had been takes place are listed as below:

a. Comparison between the implementation cost and return of investment take places on software decision making
b. In-house training upon 3 BIM software
c. Manager level to attend BIM workshop and seminar to increase the knowledge and awareness of BIM benefits and usage

However, according to respondent R3, BIM could rarely take over the role of CAD in the near future of construction industry in Malaysia. The nature of the industry which heavily relies on the CAD-based drawings is one of the reason that pull back the

implementation, as evidenced in the following statement:

"… Since then, CAD being used comprehensively. It's covered a wide range of usage such as preparation of tender and contract document, information transferring between team members within or outside company and so on. It would take a very long time probably another 10 years for the industry to change as a whole but somehow, CAD role will not be out-of-dated. Hence, we should make full use of both CAD and BIM through coordinate their existence…" Respondent R3

Piloting BIM implementation been delivered with on-the-job training concurrently right after completed the complementary training where therefore been featured as another readiness criterion. Pilot implementation will only take place in a small scale project to mitigate the risk and losses that might occur beyond control. According to R1 and R2, the focus point of pilot implementation fall on testing and adjusting the planned implementation approach to accommodate the needs of the project as well as the company by using real time data, process flow, deliverables and datelines. All these will be recorded by BIM administrator from the company as reference for future improvement in the aspect of benefits, disadvantages, and adjustment and so on.

4.1.5.1.3 Policy

According to Interviewee R3, when implementing BIM, the company preferable undertake design and build as the project delivery method even the company does not have internal architecture that provides architectural design services. Therefore, it is

crucial in selecting the capable architect that intelligent in BIM so that the BIM process flow is align with the company process flow who involved in the same project.

Besides identifying design and build as the best delivery method, Interviewee R4 mentions that the contract of the company had been revised so that the BIM process flow and deliverables can be performed in the project. It is because the previous process flow and deliverables are relying too much on CAD system which is not advantageous to BIM implementation.

4.1.5.2 Management

Table 2.3: Readiness criteria for management element

MANAGEMENT ELEMENT	
READINESS CATEGORY	**READINESS CRITERIA**
BUSINESS STRATEGY	BIM Objectives and Alignment BIM Market Demand
MANAGEMENT COMPETENCY	Risk Management Commitment and Support
LEADERSHIP	Motivation Top Down Approach

Table 4.3 summarises the six readiness criteria that was identified within the company and will be discussed in the following subchapter in details.

4.1.5.2.1 Business Strategy

All the interviewees agreed that BIM implementation must align with the company's business objective and its nature and thus been featured as another readiness criterion. The management will only decide to invest and implement a new technology/software when they can see the benefits that able to support their business operation and objectives. For a short-term business objective, the BIM implementation is used to increase the productivity and efficiency through eliminate obstacles that arises from implementing CAD. Meanwhile, it can utilise fully the existing manpower and international market opportunities in a long-term business objective.

> *"…In the international market where people are requesting for 3D models as part of the contract requirement. Hence, in order to secure the market demand and international job, company have to start implementation to build the base for now…"* Intervieweet R4

> *"…with the implementation of BIM where a lot of thing can be done automatically, hence a lot of time can be saved. This is where we can get more job where our manpower are still capable with…"* Interviewee R1

4.1.5.2.2 Management Competency

According to respondent R4, losing BIM-competent staff to their competitors due to a higher pay offering is one of the risks when implementing BIM even though this risk is yet to be materialised, however, there is a high possibility for the risk to take place once the staff achieved higher level of competency, according to Respondent R2. Therefore, the company includes the risk mitigation plan through provides training to as many staff as possible so that they can become BIM competent so that if any of them move to another company, company still have backup personnel. Hence the interruption on BIM implementation can be minimised.

Nonetheless, commitment and support from management level also been featured as another readiness criterion. All the respondents agreed that the company provides a full support when implementing BIM such as provide necessary training, technical assistance and step-by-step implementation. The consistency support from management is directly relation with staff motivation as evidenced in the following statement:

"…There are huge uncertainty awaiting when implementing BIM whereby staff are giving extra time and effort not only to build own competency but also deal with pressure from actual workload. Without the support from the management, staff will definitely demoralised when the management not solving the challenges together when them…" Interviewee R1

4.1.5.2.3 Leadership

Management ability to give motivation towards staff been featured as readiness criterion. According to respondent R2, the management understand how much staff facing the pressure when increase their competency at the same time dealing with actual work. Therefore, management would always spare time to communicate and listen to their staff by understanding what is the problem they are facing and then resolve it together. Besides, management would always communicate directly with the staff to increase their awareness of their value in the market, potential of being promoted to a higher position with a higher pay through increase their competency, according to R1. Not only that, but management will also always involve staff on board for decision making rather than directing them. This can be evidenced as follow:

> *"…Besides evaluating our evaluation report on selecting Revit, the management called few of our colleagues to contribute their judgement towards the software before buying it. They also being very attentive to our needs with arranging in-house training for the implementation of the software…"* Interviewee R3.

> *"…When we propose to the management on the benefits of BIM at the early stage before the company implement it, the management willing to listen and accept the ideas proposed by us. Only then we start to prepare the evaluation report…"* Interviewee R4.

Hence, it can be evidenced that the company engaged top-down approach in implementing BIM through setting the direction, implementation plan preparation and during the driven of implementation even though the implementation of BIM was triggered and proposed by the operational level. According to respondent R3 perspective where he has worked with the company for 7 years, top-down approach is crucial in justify the implementation of BIM is align with the business nature and objectives where at the same time to ensure the management's authority to provide adequate resources for the implementation. Therefore, this approach been identified as one of the criterion for leadership attribute under management element.

4.1.5.3 People

Table 4.4: Readiness criteria for people element

PEOPLE ELEMENT	
READINESS CATEGORY	**READINESS CRITERIA**
ROLES AND RESPONSIBILITIES	Head of Change BIM Designer Modeler BM Administrator Manager Empowerment
SKILL AND ATTITUDE	BIM Administrator Manager BIM Designer Modeler

TRAINING AND EDUCATION	Formal Training On-the-job Training
WORK ENVIRONMENT	Knowledge Capturing Knowledge Sharing

Table 4.4 summarises the ten readiness criteria that was identified within people element and will be discussed in detail in the following subchapter.

4.1.5.3.1 Roles and Responsibilities

Before the purchase of BIM software, the management realised the needs of having two new roles in the company to support the implementation after the consultation with. The two new roles are BIM Administrator and BIM Designer. According to respondent R3, both roles are required to operate the BIM software. Administrator is not only responsible to administrate, manage and facilitate all technical aspects related to BIM while but also extended to assists in any on-the-job training for the staff for BIM Designer act as the operator of the software where the responsibilities are limited to 3D model authorization and design deliverables preparation. Therefore, the new roles and responsibilities been identified as another readiness criterion.

Next readiness criteria featured within the company under the people element is the presence of Head of Change. The role and responsibility of Head of Change is varied from BIM Administrator. Administrator being responsive with all technical aspect

related with BIM while Head of Change is responsible in managing BIM implementation activities such as implementation plan preparation, lead and monitor the implementation process and liaise between management and operational team. According to respondent R3, Head of Change playing an essential role in ensuring the success of BIM implementation as evidenced below.

"…Head of Change is an important role in driving BIM implementation towards success. He has to identify all the requirements needed during the implementation and prepare for it such as training, hardware and software acquisition. He has to ensure as well adequate resources been authorized in assisting the implementation and redesign the process flow when something is not right. Most importantly is that he has to coordinate the implementation along with the business nature and company's objective so that the expectation of BIM implementation by top management can be reached…" Interviewee R3.

According to both respondent R3 and R4, empowerment also playing a crucial role to ensure the success of implementation. However, the empowerment must be adapted to specific level of responsibility so that the authority able to make the right decision throughout the change process to ensure the process able to run smoothly and effectively. This can be evidenced through involved some of the staff which includes respondent R3 and R4 to decide in the purchase of BIM software as mentioned earlier. Thus, the empowerment been identified as another readiness criterion within the company.

4.1.5.3.2 Skills and Attitude

The competency of staff's skill and attitude been identified as one of the readiness criterions to ensure the success of BIM implementation, according to all the respondents. Hence, according to respondent R3, the company will look into few aspects in selecting the competent staff to be BIM Administrator and BIM Designer. The aspects include but not limits to, have a strong technical knowledge and competent in both design and drafting through CAD and IT literate, able to manage a good relationship between team and helpful in providing support to the member, personal interest towards BIM and the ability to respond to change. However, according to respondent R4, BIM Administrator carry a heavier responsibility to ensure the success of implementation. Therefore, they require extra soft skill such as coaching skills, communication skills, leadership and troubleshooting skills. Hence, in selecting the talented and competent internal staff to hold the positions, the company has come out with an approach as evidenced below:

"…We will listen to the managers' recommendation where they will provide a name list that listed the talented and competent staff that hit the requirement because they are the one who has the close interaction with their staff. From there the manager get to know their actual competency level as well as their skills…" Interviewee R3.

4.1.5.3.3 Training and Education

There are two types of training the company engaged during the early implementation of BIM. One is formal training and another is on-the-job training which been identified

as one of the readiness criteria. Formal training was the very first training conducted in-house during the implementation. It is a complementary training provided by the software provider aim to provide a fundamental guide on the use of the software to the user. The training was conducted in-house for a duration of one week. On top of that, Respondent R4 further explained that the company do send some competent staff abroad to satisfy the needs to become a knowledgeable and competent BIM Administrator and the staff who was given such opportunity includes Respondent R3 and R4. Also, the reason to send staff abroad for a more professional formal training is due to software provider unable to provide such level of training during the early implementation as there is not much professional trainer in the market at that moment, according to Respondent R3.

After the formal training, the company takes a smaller scale of an on-going project to participate in on-the-job training. The reason to carries out on-the-job training is to provide the hands-on opportunity to the staff so that the gap between theory and practical experiences can be reduced before moving forwards to a more complex project in the future.

4.1.5.3.4 Work Environment

According to Interviewee R3, the company will document all BIM related information such as BIM workflow and training module and keep it up-to-date regularly. The reason to capture and store the information and updated from time to time is to allow the knowledge can be shared among the colleagues especially junior whereby the company believe it can help to boost and develop their staff's competency so that they are capable

in carry out assigned work task with BIM and for future improvement as well. Hence, the management requested the staff to do documentation in written manual if there are any changes occur in the technology and process. Therefore, knowledge capturing been identified as one of the readiness criteria.

Besides, Interviewee R4 further explain that a supportive work environment is crucial to ensure the success of knowledge sharing among the staff as evidence below:

> *"…It is almost impossible to expect all the staff to attend the training at the same time where it will impact and might delay the progress workflow. Hence, the company normal practice is, we will only send the selected staff to attend the training and they were responsible to teach and guide the rest of the staff after completed the training…"* Interviewee R4.

Interviewee R1 & R2 both also agreed that internal teaching and training activity does help to increase the efficiency in using the BIM software as evidenced below.

> *"…It is really helpful when we have internal expert in the company. Whenever there are new staff joining in especially fresh graduates who are not familiar with BIM, they can approach the expert anytime…"* Interviewee R1.

> *"…I think the internal training activity not only benefitted staff in practicing and revising the BIM knowledge, but it will allow them to raise questions anytime because the instructor is the one they familiar with or close to. Thus, it can help them to identify their room for improvement through looking at their weakness and strength at the same*

time…" Interviewee R2.

Hence, work environment been identified as readiness criteria within the company.

4.1.5.4 Technology

Table 4.5: Technology element that was identified as one of the readiness criteria in the company

TECHNOLOGY ELEMENT	
READINESS CATEGORY	**READINESS CRITERIA**
HARDWARE	Sufficient ICT Infrastructure
TECHNICAL SUPPORT	Technical Support
SOFTWARE	Compatibility and Interoperability ICT System Review

Table 4.5 summaries the criteria that was identified within the company for technology element. Four readiness criteria were identified and sorted accordingly under each category and the details of each criterion will be discussed further in the following subchapter.

4.1.5.4.1 Hardware

According to Interviewee R3, during the time when management seeking their opinion towards BIM implementation, interviewee raised his concern about insufficient support from the current graphic and RAM within the desktop in the company. The insufficient support not only will make the BIM software unable to run smoothly but reduce the interest of using by user where user will face lagging problem often. Hence, the company decided to upgrade the current desktop RAM and graphic card as a start to support the BIM implementation. Meanwhile, Interviewee R4 proposed to the management to consider acquire new desktop in the future where interviewee foresees that upgrading may not an option to provide a long-term support to the use of BIM software. Below shows the evidence that support the criteria featured in the company:

> *"…Computer infrastructure is very important to ensure the application run smoothly. Without it, BIM implementation could not be optimised…"* Interviewee R3.

> *"…BIM will be used by QS especially to carry out our work task. User will feel annoying if the application keeps lagging eventually will drag our progress of work too…"* Interviewee R1.

> *"…Before the implementation of BIM, we consulted with software vendor to identify the ideal hardware requirement to support the application and found out our current hardware is insufficient to support. Hence, we upgraded the RAM and graphic card to satisfy the needs at that moment. However, it is*

not a permanent solution to solve the problem where the motherboard still insufficient to support the higher capacity of RAM and graphic card for the more advance application such as Revit. That's why we need to invest in a new desktop…" Interviewee R4.

4.1.5.4.2 Technical Support

Another crucial factor that recognized by all the interviewees that will impact the success of BIM implementation is the sufficient support provided by software vendor. The intention of the support is to support the staff and avoid any disruption arises during the implementation and updating if there is any new update or version of the software. Although it is compulsory for software vendor to provides technical supports such as troubleshooting, however, the company unable to rely on and put too much expectation towards software vendor as they unable to assists in implementation when some of the problem requires expertise such as BIM consultants to resolve. Therefore, sufficient support been identified as another readiness criterion within the company.

4.1.5.4.3 Software

According to interviewee R3 and R4, interoperability between BIM software and CAD system is very important as most of the company in Malaysia still adopting CAD system. On top of that, the mass usage of hardcopy drawing in the market as the local authority and client's requirement to delivery CAD drawing instead of BIM model. Hence, to reduce the risk during data transferring from CAD to BIM software especially when drafting take place, thus, interoperability of BIM software with CAD

is very important and identified as another readiness criterion.

Nonetheless, Interviewee R4 further add on that, BIM hardware and software features and advancement keep changing over time to fulfill the market needs where some of the features require only updates while some require to purchase a new software extension so that the needs of the company can be fulfilled. Therefore, to ensure the company existing hardware and software is enough to support the advancement so that system can run smoothly, Administrator should carry out ICT reviewing regularly on both hardware and software to keep the latest technology alongside. Thus, another readiness criterion been identified within the company.

4.2 SUMMARY

In this chapter, qualitative form of data acquisition been adopted to gather information. Through conducting a case study, researcher able to capture more information and all relevant to BIM implementation requirements. This leads to a better understanding of the reason and logic behind each of the identified readiness criteria relevant to people, process, management and technology elements. Each of the identified criterion is then discussed further in details accordingly.

CHAPTER 5: DISCUSSION

5.1 Introduction

This chapter will discuss about the discoveries of the research in response to answer the following objectives which was identified earlier in Chapter 1.

1. To identify the stakeholder that utilise BIM throughout project lifecycle for government project
2. To identify the benefits for adopting BIM in the construction processes for government project
3. To identify the challenges encountered for adopting BIM in the construction processes for government project
4. To investigate the level of readiness in adoption of BIM throughout project lifecycle for government project

5.2 To identify the stakeholder that utilise BIM throughout project lifecycle for government project

As discussed earlier in this chapter, the stakeholder that utilised BIM throughout project lifecycle was identified in chapter 4 and illustrated in the figure below. Taken the government project in this case study where the current status of the project in under construction, hence, the project lifecyle up to execution stage only.

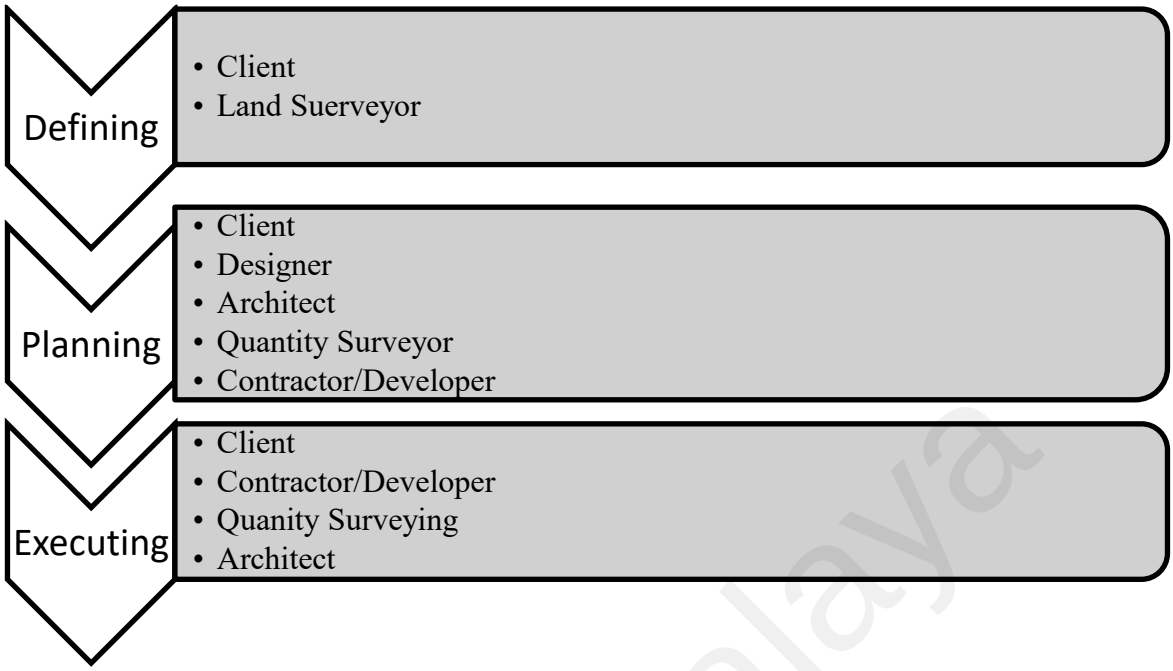

Figure 5.1: Stakeholder that utilise BIM throughout the Project Lifecycle

As shown in the figure above, showing the stakeholder identified by interviewees that utilised BIM throughout the project lifecycle for ongoing project with government in Brickfield. Company A playing the role as contractor that currently under the stage of executing construction works. As illustrated in Figure 4, company A has involved in planning and executing stage which is the construction stage of the project. According to Interviewee R1 and R2, they used BIM in material taking off in planning stage as well as have a visualization model go through to identify if there are any design flaws based on their experiences. Even there is Quantity Surveyor involved in the project, however, Company A will always conduct material taking-off through BIM internally as well to ensure the accuracy of the quantity of material that had been take off by external party so that a more accurate cost estimation can be provided. On top of that, Company A able to plan accordingly the resources in both monetary and human

resources to ensure the sustainability of operation of the company. Nonetheless, according to Interviewee R2, he able to plan risk ahead through visualization walkthrough using BIM. This will greatly benefit in reduction of rework and expenses that can be avoided when the risk can be foreseen and managed prior to happens.

While during the executing stage which is the construction stage of the project, BIM enable Interviewee R1 and R2 in monitoring work progress through updating the real time data to BIM in which the data enable them to manage resources and assigns tasks efficiently. They even can link BIM to schedule while recording labour productivity information to bring transparency on construction progression. However, the benefits of using BIM in part can only be shared among the team internally where the rest of the stakeholder did not use the same BIM software.

However, author realised that the research problem of who are the stakeholder that utilise BIM throughout the project lifecycle and objective to identify the stakeholder that utilise BIM throughout the project lifecycle did not reflect the essential to assist researcher to achieve the main objective of the research which is to investigate the level of readiness in BIM software adoption throughout the project lifecycle for Company A. Meanwhile, the level of readiness within an organization can be investigated through the identified readiness element in Chapter 2 Literature Review comprises of process, people, management and technology aspects.

5.3 The Benefits of BIM implementation

As identified in chapter 4 on the benefits of BIM implementation, it if found that there are some of the benefits which was identified earlier in chapter 2 Literature Review, same or bring to the same meaning of the benefits identified in chapter 4. Table below shows the linkage of benefits from results obtained through virtual interview with Company A, with literature review.

Table 5.1: Comparison between benefits identified through literature review with results obtained from Company A

Benefits Obtained from Literature Review	**Investigated Results from Company A**
Increase efficiency and productivity of the project team	Time saving where material take off and clash detection can be automated
Real-time update and assess efficient tracking and monitoring process	
Detect clashes due to design error	Clash detection and be automated
Platform to share latest design and information	Consistency in keeping team member get the latest information
Enhance communication and maintain synchronization	Better communication among team member
Reduction of rework, cost saving	

From Table 5.1 as shown above, out of 6 benefits that most of the researchers highlights in their research paper, there are 4 benefits obtained that are related with the identified benefits in literature review. Research question of what are the benefits for adopting BIM in the construction process was answered. However, it is worth mentioning that none of the interviewee mention about the benefits of reduction of rework and tracking and monitoring process through BIM during the virtual interview where this is out of the expectation of the author.

5.4 The Challenges of BIM implementation

As identified in chapter 4 on the challenges of BIM implementation, it if found that there are some of the challenges which was identified earlier in chapter 2, literature review, same or bring to the same meaning of the challenges identified in chapter 4. Table below shows the linkage of benefits from results obtained through virtual interview with Company A, with literature review.

Table 5.2: Comparison between benefits identified through literature review with results obtained from Company A

Challenges Obtained from Literature Review	**Investigated Results from Company A**
Interoperability Issues	Interoperability of software
Copy-right of Design	
Authority to edit the model	

Amount of effort put in in conducting training or hiring talented BIM employee that will influence the whole productivity of the organisation	
	Reluctant to change by senior staff
	Negative perception towards new technology

As shown in Table 5.2 above, author extracted 4 main challenges that highlight by researcher in their research paper. However, there is only 1 challenge that mentioned by interviewees fall under the same category of the identified challenges through literature review. Meanwhile, the interviewees of this research paper mentioned another 2 challenges which are reluctant to change by senior staff and negative perception towards new technology whereby author believe that even it is not captured during literature review, however, these issues are negligible where it will directly influence not only the performance of the project team but the overall project performance in term of quality, time and cost as well as the successfulness of BIM implementation within the organization. Lastly, the research question of the paper what are the challenges encountered for adopting BIM in the construction processes for government project answered which reach the expectation of the author.

5.5 The level of readiness in BIM implementation

Throughout the research, it is fair to say that the Company A has a thorough context of BIM implementation within their company with a high level of BIM implementation which can be evidenced by the existence of BIM associates roles such as BIM Administrators/Manager with more than 10 years of experience in BIM industry, incorporated BIM into the standard operating procedure (SOP) and higher level of details 3D models. The last-mentioned has enabled the company to merge activities such as extract drawings, conduct material taking-off, carry out clash detection and walkthrough review in their workflow. Besides, throughout the research to investigate the readiness level based on all identified readiness category, found that the Company A has comply accordingly through all the criteria.

Table 5.3: Summaries of readiness criteria that identified within the company

READINESS CATEGORY		**READINESS CRITERIA**
PROCESS	Process Change Strategy	Process Flow Redesign Small and Incremental Approach Incentive and Reward
	Implementation Management	Implementation Plan Adequate Resources Pilot Project BIM CAD Coordination
	Policy	Design and Build Contract Amendment

MANAGEMENT	Business Strategy	BIM Objectives Alignment BIM Market Demand
	Management Competency	Risk Management Commitment and Support
	Leadership	Motivation Top-down Approach
PEOPLE	Roles and Responsibilities	Head of Change BIM Designer/Modeller BIM Administrator/Manager Empowerment
	Skill and Attitude	BIM Administrator/Manager BIM Designer/Modeller
	Training and Education	Formal Training On-the-job Training
	Work Environment	Knowledge Capturing Knowledge Sharing
TECHNOLOGY	Hardware	Sufficient ICT Infrastructure
	Technical Support	Technical Support
	Software	Compatibility and Interoperability ICT System Review

As shown in Table 5.3 above, the criteria to assess the BIM readiness level comprises of 4 main elements which is process, management, people and technology. Each of the elements comprises of readiness categories where each of the categories comprises of readiness criteria that identified within the company through conducted virtual interview with the interviewees.

To answer the research question of what is the level of readiness in adoption of BIM throughout project lifecycle, author has gone through exploration for each of the readiness categories with all the interviewees. For process change element, author explored the degree to which the Company A has changes it existing process flow to adopt with BIM implementation while at the same time remain its overall business objective and realised Company A has redesign the process flow, adopting a small and incremental approach within the organization named stage-to-stage approach and implement incentive and rewards program so that each of the staff within the organization can improve progressively with determination. Besides that, author realised the management as well performs a good management practice in the organization through having a BIM implementation plan to stimulate the implementation that aligned with company's policy, mission and vision which support the operation and business nature of the company. Nonetheless, Company A has a suitable delivery method which is design and build since they have the authority to choose BIM-capable architect to provide the services to the project. Also, Company A has revised the policy to incorporate BIM process flow and deliverables so that CAD environment can be changed.

For management element, author found that the management of Company A is very intelligent and careful in considering BIM implementation where will only decide to invest and implement a new technology/software when they can see the benefits that able to support their business operation and objectives. Besides, the management also provide necessary and adequate amount of training, technical assistance and step-by-step implementation to the selected competent staff to increase their competency level. A consistent support from management which will spare some time to carry out one-to-one communication with the staff that happened in Company A also contributing to the high level of BIM implementation.

On top of that, the management created another special role such as BIM Manager and BIM Administrator in the organization with the realization of incapability of resources to incorporate BIM. Hence, these roles been created and chosen from the existing staff in the company. BIM Director will look at their competency level as well as their attitude in working through recommendation by their respective manager. To increase their competency level, management had arranged formal training and on-the-job training to the staff during the BIM implementation so that the gap between theory and practical experiences can be reduced before moving forwards to a more complex project in the future. The management also requested the staff to update BIM manual in written form when there is any revision in the process flow so that the knowledge can be capture, store and share among staff. A supportive work environment that can be found in Company A in encouraging teaching and training in the workplace will also increase the success of BIM implementation.

Last but not least, in term of technology, Company A posses a high level of readiness also where they have a sufficient ICT infrastructure to support BIM implementation through upgrading the RAM and graphic card of the existing desktop in the organization. Not only that, the company also considering to acquire new desktop where they projected that the existing hardware and software is insufficient to support more advance software that the organization might need in the future. Hence, the company will conduct ICT review regularly to monitor their existing hardware and software support.

5.5 SUMMARY

This chapter highlighted the level of readiness of BIM within Company A which were related to achieve the following objectives:

1. To identify the stakeholder that utilise BIM throughout project lifecycle for government project
2. To identify the benefits for adopting BIM in the construction processes for government project
3. To identify the challenges encountered for adopting BIM in the construction processes for government project
4. To investigate the level of readiness in adoption of BIM throughout project lifecycle for government project.

For objective 1, it is found that the stakeholder identification does not reflect the essential in investigating the main objective with is objective 4 where the readiness criteria is more appropriate to assess based on the organization instead of project team

in which project team comprises of many stakeholders that from different organization. Hence, it is hardly to assess the readiness level of BIM implementation for the particular project.

Meanwhile, for objective 2, the identified benefit in the company includes better communication among team member, consistency in keeping team member get the latest information and also time saving where things can be automated. While for objective 3, the identified challenge in the company includes reluctant to change by senior staff, interoperability issues of software and negative perception towards new technology.

For objective 4, it is found that the company has a high level of readiness in BIM adoption throughout the project lifecycle. This can be evidenced through incorporating BIM in the standard operating procedure, the creation of special roles and responsibilities, supportive action and work environment by the management and upgrading of existing hardware and software application.

CHAPTER 6: CONCLUSIONS

6.1 Introduction

The background of this research project is based on the fact that low implementation of BIM by most of the organisation either public or private sector in Malaysia. The reasons that being reported by most of the research indicating that they are not using BIM due to numerous reason such as lack of knowledge, high cost, lack of awareness and or difficult to shift from traditional practices where these issues happened since year 2013. Therefore, this research project aims are to investigate the readiness level of BIM implementation for government project while highlighting the benefits and challenges of implementation. The significant of this study if to provide a better insight to the government the rooms for improvement in the providing support in introducing BIM from government and also the practitioner the criteria to comply with prior to BIM implementation in order to enjoy the greatest benefits that brought by BIM.

6.2 Achievement of Aim

In order to achieve the aims of examine the level of readiness of BIM implementation throughout the project lifecyle for government project, Company A been targeted for this research is because the company is government-linked company were involved in government project which includes the on-going project in Brickfield. Virtual interview being conducted as the methodology to obtain data and content analysis is

then being carried out. Hence, the level of readiness of BIM implementation obtained.

6.2.1 Achievement of Objective 1: to identify the stakeholder that utilise BIM throughout project lifecycle for government project

This research project identifies the stakeholder that involved in the Brickfield project through interview session that conducted with Interviewees from Company A. However, after conducting the interview, author realised that BIM implementation readiness level is more appropriate to assess within the organization instead of the project where a project comprises of numerous stakeholders and each stakeholder is from different background and organization. Hence, is it hard to justify and investigate the readiness level of BIM implementation for the particular project within a short time-frame. On top of that, this study found that stakeholder identification is not essential in identifying the overall benefits and challenges of BIM implementation as well as the readiness level.

6.2.1 Achievement of Objective 2: to identify the benefits for adopting BIM in the construction processes for government project

Through the content analysis that was conducted for this research paper, benefits for adopting BIM in the construction process been identified. The top mentioned benefits include time saving, clash detection, consistency in keeping team member get the latest information and better communication among team members. Besides, the research finds that the mentioned benefits are the similar with the benefits that identified through literature review.

6.2.2 Achievement of Objective 3: to identify the challenges encountered for adopting BIM in the construction processes for government project

Through the content analysis that was conducted for this research paper, challenges that those interviewees encountered during the adoption of BIM in the construction process been identified. The top mentioned challenges include reluctant to change by senior staff, interoperability issues of software and negative perception towards new technology. Besides, the research finds beside interoperability issues of software, negative perception towards new technology and reluctancy of senior staff to change from traditional practice were not in the list of identified challenges through literature review. However, it is not the new challenges that faced by Company A but did mention by other researchers.

6.2.3 Achievement of Objective 4: to investigate the level of readiness in adoption of BIM throughout project lifecycle for government project

In term of the readiness level, it has been assess based on the readiness components that identified in literature review where each components contain each readiness category. In overall, this study explored that the company that involved in government project possess a high level of readiness in BIM implementation which will benefits the project indirectly.

6.3 Research Significance

Many of the studies on level of BIM implementation in Malaysia are usually conducted through questionnaire and survey from the level of user. In contrast, this research paper use the theoretical framework that developed by Ahmad in year 2013 to assess the readiness level of the organisation in implementing BIM. Therefore, this study is of great significance. This research paper also able to provide a better insight to the government the rooms for improvement in the support from the government in introducing BIM so that the goal set to achieve 50% adoption by year 2021 and 80% by year 2025 can be achieved. In return, it will help in promoting BIM adoption in construction industry which will improve the overall performance and quality of the Malaysian construction industry.

6.4 Recommendation for Future Study

Nevertheless, this study has limitation that only able to conduct interview with one of the stakeholder's organisation due to time limitation. Hence, it is expected the subsequent studies could expand the range of interviewee to involve all the stakeholder's organisation throughout the project lifecycle in the research to investigate the level of readiness for a project

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