CHALLENGE OF BUILDING INFORMATION MODELLING (BIM) IMPLEMENTATION IN MALAYSIA AEC INDUSTRY

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ABSTRAK

Pemodelan maklumat bangunan (BIM) adalah konsep termaju untuk majoriti syarikat yang beroperasi dalam industri AEC. BIM menyediakan paradigma baru untuk mereka bentuk, membina, mengendali dan menyelenggara kemudahan. Walaupun dengan penggunaan khusus, pihak terlibat boleh mengalami kesulitan semasa pelaksanaan projek atau dalam organisasi. Industri AEC di Malaysia sangat menarik dan pelaksanaan teknologi baru dan sistem pembinaan telah menjadi perhatian utama bagi pihak yang terlibat. Oleh itu, kajian ini bertujuan untuk mengenal pasti unsur-unsur yang mencabar pelaksanaan BIM dalam industri AEC Malaysia. Tiga puluh lima cabaran dengan pelaksanaan BIM telah dikenalpasti dan kebanyakan faktor boleh dikaitkan dengan unit organisasi. Data telah diuruskan melalui soal selidik dan menumpukan faktor-faktor tersebut adalah untuk membantu pihak terlibat yang utama untuk menangani isu-isu seperti keperluan mereka melaksanakan masa dan kewangan dengan pelaksanaan BIM dalam industri AEC Malaysia.

ABSTRACT

Building information Modelling (BIM) is an advanced concept for the majority of companies operating in AEC industry. BIM provide a new paradigm to design, construct, operate and maintain a facility. However, even with the dedicated use, stakeholders can go through into troubles during its implementation on a project or within an organization. The AEC industry in Malaysia is very compelling and the implementation of new technological advancements and construction systems has been a major concern for the stakeholders. Therefore, the study aims to identify the elements challenging of implementation of BIM in Malaysian AEC industry. Thirty-five challenges with BIM implementation were identified and most of the factors could be correlated with the organization unit. The data has been managed through designed questionnaires and the prioritization of such factors is relied upon to help the main stakeholders to address the issues as per their need which will spare parcel of time and financial with implementation if BIM in Malaysian AEC industry

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS

%	Percentage

LIST OF ABBREVIATIONS

BIM	Building Information Modelling
AEC	Architecture Engineering Construction
PWD	Director of the Public Works Department
CIDB	Construction Industry Development Board
CITP	Construction Industry Transformation Program
SMEs	Small and Medium Enterprises
GSA	General Services Administration
PBS	Public Building Service
IFCs	Industry Foundation Class
CPCF	Construction Productivity and Capability Fund
CORONET	Construction and Real Estate Network
NATSPEC	National Specification
CRC-CI	Corporate Research Centre for Construction Innovation
ANZRS	Australian and New Zealand Revit Standards
ROI	Return on Investment
CIMP	Construction Industry Master Plan
RII	Relative Importance Index

CHAPTER 1

INTRODUCTION

1.1 Introduction of Research

Construction is the process of constructing a facility, building or infrastructure. Construction process requires a lot of team working and involvement of many parties. The construction industry is usually known to be one of the most challenging industries in many countries. This study explains about Building Information Modelling, which one of the mediums used by companies to smoothly manage and command projects. BIM is a model defining the physical and the functional characteristics of a facility in a digital representation (Azhar et. al.,2008). The concept of Building Information Modelling is to build a building in a virtual environment before its actual physical construction so that problems along with their potential impacts expected to be encountered during actual construction stage can be worked out and analyzed in advance (S. Azhar et al., 2011).

Nowadays, most of the developed countries use this medium in their construction industry field. For example, Australia is the leading country in implementing BIM (18-75%) followed by the United States (31%), Europe (16%), the Middle East countries (11%) and India (9%) that shown in Figure 1. Inferable from expanded awareness about its points of benefits, AEC industry companies in Malaysia start to use this medium in their projects.

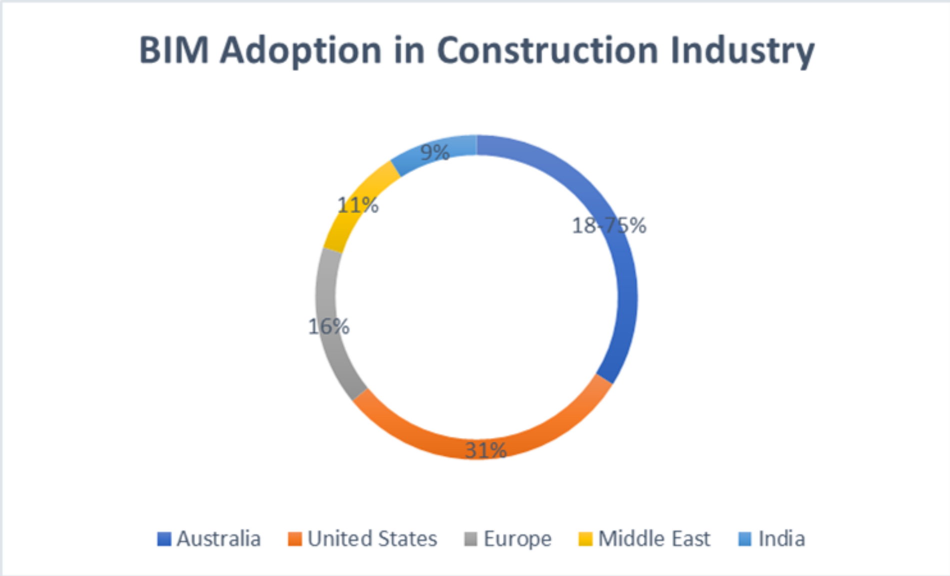


Figure 1.1: Countries that use BIM (Sawney, 2014)

The progress of BIM in Malaysia has been operated by the private sector since 2009. The suggestion to implement BIM in Malaysia was initiated by the Director of the Public Works Department (PWD) in 2007. The first government project to use this BIM medium methodology was announced in 2010. BIM implementation need the development of dependable tools for information exchange between various software tools while authorize efficient and direct coordination and monitoring processes between project participant and team members.

The construction industry of Malaysia is very competitive in quality. The country is progressing with a vision 2020 and the AEC industry in a crucial element of this vision. The implementation of new technological advancements and construction medium has been prime concerns for its stakeholders. However, the implementation of BIM in such competitive industry is observed to be restricted and its implementation has not been as rewarding as it should have been. Although, there is now a deliberate concern about this technology and the industry professional are realizing the potential benefits of BIM. This study is being regulated to emphasize some of the factors that are specifically affecting the implementation of BIM in Malaysian AEC industry.

1.2 Problem Statement of this Research

The AEC industry in Malaysia need to catch up with the pace of another development countries that already used this BIM medium in their construction project. Malaysia is still moving slowly with the implementation of BIM in the AEC industry. Chief executive of The Construction Industry Development Board (CIDB), Datuk Ahmad Asri Abdul Hamid has suggested the compulsory use of BIM in project sectors by 2020. This move was to emerged the digital implementation by industry specialist as Malaysia was set to begin the fourth industrial revolution 4.0.

The proposition is under the Construction Industry Transformation Program (CITP), yet we have not decided the (implementation) period in light of the fact that the acknowledgment is as yet not wide going despite the fact that we have presented the utilization of BIM. In the construction sector, BIM has proved to be a valuable technique that helped professionals reduce uncertainties and successfully execute a project. BIM can be used from planning to operation at all phases of the construction process. Unfortunately, implementation of BIM is very slow in the Malaysian construction industry. This study is conducted to identify the factors challenging the implementation of BIM in Malaysian AEC industry (Gardezi et al., 2014).

The next generation of construction specialists will be train in several universities through collaborating with CIDB that consisted of technical training and communication skill. The implementation of such innovative and new technologies is a necessary for companies to remain competitive and be able to deliver projects in a timely and cost-effective manner and this change needs to happen quickly and at scale.

1.3 Objective of Research

The aim of this research to know the factors challenging the implementation of BIM in Malaysian AEC industry. In order to achieve that objective, the following objectives have been identified:

- To collect and analyses data from company respondents.
- To puzzle out the factors that challenges the implementation of BIM in Malaysia AEC industry.

1.4 Scope of Research

The research was focus on study the factor challenging the implementation of Building Information Modelling in Malaysian AEC industry. The scope of the research is mainly focus on literature review and a questionnaire survey. The questionnaire survey would be designed based on the factors challenging the implementation of BIM in construction industry from international reviews. The targeted respondent involved in this research is architect, engineer, contractor and developer. This questionnaire also only addressed to the Grade VII and below AEC professional so that the result of the data will be more accurate in order to know the factors challenging in Malaysia. The respondent will be consisted of BIM user and non-BIM user as this will make sure the factors why the implementation of BIM in Malaysia still in poor condition.

1.5 Significance of Research

The importance of the research are:

i. Identifying the causes of factors challenging in BIM implementation, this study of result will be giving the certainly parties involve, so that they will know any factors challenging that occur in their project and carrying out the works within the time, budget and quality.

ii. Contribute recommendation on preventing or reducing the factors challenging in AEC project in order to minimize the human error and reduce risk of cost overrun.

Previous studies had shown that the study about the factors challenging will provide useful information to the practitioners to be more considering using BIM technology in their project (S. Azhar et al., 2011). So, it is clear that this study will help the contractors, the consultants, and the owners and all the parties involved to overcome any factor that could lead towards BIM implementation challenge in the future AEC industry.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter will explain the literature review about the implementation of Building Information Modelling (BIM) in AEC industry. First, this study will explain about the definition and tool of Building Information Modelling and development of BIM generally. Then this study will explain about BIM implementation trend in other countries and the challenges and advantages of using BIM in the AEC industry.

2.2 Definition of Building Information Modelling (BIM)

According to (Enegbuma et al., 2014), Building Information Modelling (BIM) is the process of generating and managing building data during its life cycle. Meanwhile, (Sawhney, 2014) classifies BIM as not just a software tool or simply a technology that can be acquired and implemented. It is rather a paradigm that combines technology with people and process issues in the industry. This results in a tectonic shift in the way we deliver the built environment.

In 2014, CIDB has organized a seminar entitled Issues and Challenge in Implementing Building Information Modelling for Small and Medium Enterprises (SMEs) introduced BIM as one of the emerging technologies to be deployed in design, construction and facility management, in which a digital representation of the building is created to facilitate the exchange and interoperability of information in digital format.

According to (Thurairajah et al., 2013), Building Information Modelling represents the formation of digital models used during the planning, design, construction and operation stages of a facility's life. (Latiffi et al., 2013) referred to BIM as a set of digital tools that can help manage the effectiveness of a construction project. (Zahrizan et al., 2014) stated that BIM can be viewed as a combination of advanced processes and technology that offers a platform for collaboration between different parties in construction projects by exploiting the use of information technology.

As stated by (Arayici et al., 2012), in the simplest of terms, BIM is the utilization of a database infrastructure to encapsulate built facilities with specific viewpoints of stakeholders. It is a methodology to integrate digital descriptions of building objects and their relationship with others in a precise manner so that stakeholders can query, simulate, and estimate activities and their effects on the building process as a life-cycle entity. Therefore, BIM can help by providing the required value judgments that satisfy their owners and occupants for creating a more sustainable infrastructure.

BIM has many definitions and can be illustrated in many different ways. Table 2.1 summarizes the variety of definitions.

Table 2.1: BIM Definitions

No.	Statement	Author
1.	The utilisation of a database infrastructure to encapsulate built facilities with specific viewpoints of stakeholders	(Arayici et al., 2012)
2.	Building Information Modelling (BIM) represents the formation of digital models for use during the planning, design, construction and operation stages of a facility's life.	(Thurairajah et al., 2013)
3.	A set of digital tools that can manage the construction project's effectiveness	(Latiffi et al., 2013)
4.	BIM is one of the new emerging technologies to be deployed in design, construction and facility management, where a digital representation of the building is created to facilitate the exchange and interoperability of information in digital format.	CIDB (2014)

5.	BIM is not just a software tool or simply a technology that can be acquired and implemented.	(Sawhney, 2014)
6.	The process of generating and managing building data during the building's life cycle	(Enegbuma et al., 2014)
7.	BIM can be viewed as a combination of advanced process and technology that offers a platform for collaboration between different parties in the construction project by exploiting the uses of Information Technology (IT).	(Zahrizan et al., 2014)

2.2.1 BIM Tools

By cause of to the complexity of collecting the relevant information during the construction of a BIM project, some companies have specifically designed software for working in a BIM framework. These packages include the Bentley AECOsim Designer, ArchiCAD, Tekla Structures, Autodesk Revit, Synchro PRO and Vector Works, among others, as reference to the (Guidelines, 2017) Autodesk Revit Handbook. The Software differs from the other designing tools such as AutoCAD since they provide additional information in building mode, such as time, cost, details of manufacturers, sustainability and maintenance.

Autodesk Revit is probably the biggest example. Autodesk Revit is developing information modeling software, designers, contractors and architects. It enables users to design a building structure and its components in 3D, annotate the model in 2D drafting element and obtain construction information using the database of the building model. Revit is built of 4D design elements and contains tools to plan and monitor different life cycle stages from concept to construction and, subsequently, demolition. This is explained in (Latiffi et al., 2013)'s research report.

(Latiffi et al., 2013) also emphasized the advantage of the use of Revit in their research report. In the field of construction design, Revit can be used as a tool of collaboration between different subjects. Players from different disciplines with support from the BIM tools can implement the BIM in the Malaysian construction industry. The tools which can be used by every player are shown in Figure 2.1. It deals with the program from different unique points of view. Each perspective concentrates on fulfilling the task of the discipline. Software companies examine the existing process of working flow first to determine whether such a complex tool of collaboration is needed.

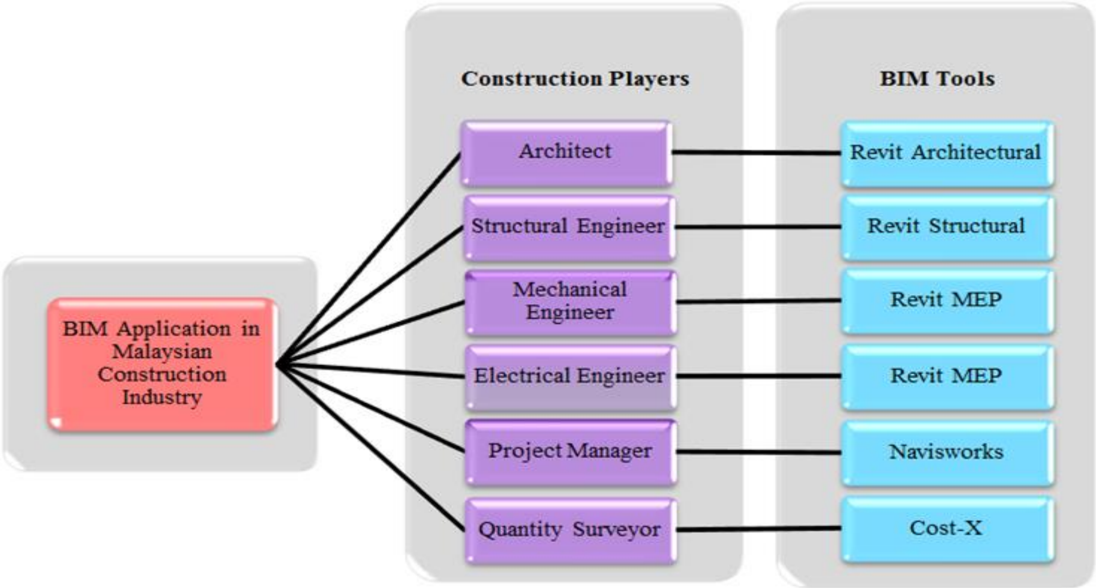


Figure 2.1: BIM tools suggested by the Director of Public Works Department (PWD) in 2007 (Latiffi et al., 2013)

2.3 BIM Development Generally

The concept of BIM can be discovered back to the earliest days of computing in the 1960s and firm modelling program began to appear in the 1970s and 1980s. The development of the ArchiCAD software program in 1982 in Hungary is vision by many as the real beginning of BIM and the development of the Revit software program in 2000 saw a real switch to effective BIM implementation (Bergin, 2010). Although the technology support BIM has been throughout for over two decades BIM implementation and practice has been comparatively unhurried in the construction industry compared to industries such as manufacturing and engineering. Nevertheless, there has been a notable switch in momentum over the last five years as technology and implementation matter enhance and the industry notice the notable benefits to be acquired from the use of this technology (RICS, 2013).

A range of research is also enhancing to address implementation matter for the industry (Ahmad et al., 2013) and to commune the advantages of effective implementation to key industry players (Cook, 2014). (McGraw Hill, 2014) has been trailing the progression and implementation of BIM in global construction industry since 2007 across immense global surveys. They have established notable change over that duration and quite considerable implementation roses over the past few years in specific. In North America their survey results displayed that BIM adoption by contractors' roses from 28% in 2007 to 71% in 2012.

Their latest overview in 2013 consist of respondent from 727 contractors from ten of the massive construction markets in the world which are Australia, Brazil, Canada, France, Germany, Japan, New Zealand, South Korea, the United Kingdom and the United states. They also manage approximate analysis of the markets in China and India to discover BIM trends in two countries that constitute roughly one-third of the earth population. They established notable increase rate in implementation.

A huge latest development was the latest decision in January 2014 by the European Parliament to modernize European public acquisition regulation by recommending the use of electronic tools like BIM.

2.3.1 United States of America

The United States has long been a global head in the construction industry in the development and implementation of BIM (Wong et al., 2009). In the United States the US General Services Administration (GSA) has developed the implementation of BIM on public projects. The GSA in charge for all federal facilities construction and operation in US. In 2003 they initiated a national 3D-4D-BIM program across its Public Building Service (PBS) Office. In 2007 they required the use of BIM to validate the spatial program throughout its project (Khemlani L., 2012). They also have evolved a range of guidelines and criterion that consisted a National BIM Standard that is internationally recognized. The GSA are clear leaders in measures to implement BIM (Gajendran et al., 2012). As a main client in the public sector with roughly 8700 buildings and over 300 million feet of space throughout the United States this program has had an immense influence on BIM adoption shows the value for the industry of main customers and government leadership.

The next stage for GSA in BIM implementation is discovering the use of BIM technology across the life cycle of the project in the following areas: temporal program validation, 4D phasing, laser scanning, energy and viability, circulation and security approval, and construction aspects.

2.3.2 United Kingdom

In the United Kingdom the government has initiated a bim implementation plan for the UK construction industry, considered by many to be the world's most optimistic and developed central BIM implementation program in the world (HM Government, 2012). The intention is to develop the UK industry into a global BIM figurehead in a short period of time (Withers, 2012). The UK Government Construction Strategy was launched in 2011 with the purpose of requiring BIM for all government projects by 2016 across a 5-year period implementation plan. BIM is noticed as central to the goal of the government in attaining 20% saving in acquisition value (Cabinet Office, 2011). In the UK construction industry, this approach has a significant effect as companies face the reality of creating the technological capabilities needed to satisfy these standards. The UK government has set up a BIM task force to support both public sector customers and the supply chain of the private sector in redeveloping their employment practices to enhance BIM delivery (McGraw Hill, 2014).

2.3.3 Scandinavian Zone

The Scandinavian Region is also a global BIM implementation leader. Norway, Denmark and Finland early practiced the archicad software and were some of the first countries to conform model-based design and promote interoperability and open standards. They also the production essential of Industry Foundation Class (IFCs) and other interoperability programs. According to (Khemlani L., 2012), the schematic design is an important building element in this region and the model-based BIM technology is optimal for this construction approach. The respective governments in this continent also provide considerable support and opportunities for BIM technology development and implementation. The Finnish Government have infused laboriously in the construction industry's IT research, which is strongly supported (Granholm, 2011). A book for this industry entitled Universal BIM Guide has been published which is being strongly supported. The Finnish sector is a main factor of BIM implementation with senate properties, a major government body responsible for managing national property assets, making headway and needing IFC-compliant BIM modeling since 2007.

In Denmark, the government truly support the implementation of BIM and invests in development and research (Granholm, 2011). Denmark is also the development leader in a new BIM classification level by Cuneco, a center in construction for productivity. The purpose is to initiate this level for all the European Union zone and potentially for global use, not only at Denmark. This new BIM evaluation level is of great importance to the European Union and its growth has been of global interest (PR Web, 2013).

In Norway, a firm called Statbygg conduct the BIM implementation that responsible for construction, management and development of government building. Since 2007, they used BIM technology in their project and needed IFC accommodating BIM since 2010.

2.3.4 Singapore

An approach has been emerged by Singapore Building and Construction Authority (BCA) to widely implement BIM on their public project (Granholm, 2011). Construction Productivity and capability Fund (CPCF) has been initiated by the government with BIM as a main target with 250 million funds. In addition, Construction and Real Estate Network (CORONET) program also was initiated in 2000 to move industry transition by using information technology. CORONET offers the information sharing infrastructure for all project parties involved. System for development practice called CORONET e-Plan is an advance capability to uplift the AEC industry to implement BIM. Architects and engineers will be enabled to check their BIM designed facilities by the system for regulatory command across an online gateway. The Industry Foundation Classes (IFCs) has been acquired by the government as the medium for BIM implementation.

2.3.5 Australia

BIM implementation is not presently extensive yet in Australia and there has not been any command from the government to use BIM in on construction project. However, the interest in BIM implementation has stepped up over the previous five years as a result of a number of initiatives to participate and notify project stakeholders about eventual gains in productivity and gain competitive edge. All the inventiveness involved the development of Australasian BIM guides such as the 'National BIM Guides' by the National Specification (NATSPEC), 'National Guidelines for Digital Modelling' by the Corporate Research Centre for Construction Innovation (CRC-CI), the 'Australian and New Zealand Revit Standards' (ANZRS) and the BIM-MEPAUS guidelines and models. The 'building smart' organization carry on to be a main lead role in BIM development and implementation in Australia that count in parties with a number of software traders to encourage the concept of 'Open BIM'.

2.3.6 South Korea

According to (McGraw Hill, 2014), the amount of BIM implementation is comparatively small in their zone compared to other countries. South Korea is known as a "high -tech" country reputation which is surprising for all and the country also being one of the top groups in school teaching in the utilizing of information technology.

2.3.7 Japan

According to (McGraw Hill, 2014)**,** BIM implementation in japan was discovered to have a higher amount of implementation. Almost all of the contractor's survey respondents reported a beneficial Return on Investment (ROI) with BIM implementation in their study. BIM's uses for environmental management, model-driven robotics and post-construction activities have also been comparatively high.

2.3.8 Brazil

In Latin America, Brazil is the largest country and economy so there has been a main effect on the South America zone. Construction industry in Brazil is increasing and being assisted by the organizing of main events such as the FIFA World Cup in 2014 and the Olympics in 2016. There are a great deal of worldwide firms working in brazil that are affecting the BIM scene and lifting the dimension of BIM usage by the nearby market. According to (McGraw Hill, 2014), Brazilian industry was comparatively new to implement BIM by the global survey of contractors. But the industry is inadequate leadership and a composed methodology from government.

2.3.9 China

BIM implementation is still in the starting point in China. A study handle by the China Construction Industry Association in 2012 found that less than 15% of 388 surveyed Chinese Construction companies used BIM (McGraw Hill, 2014). McGraw Hill additionally embraced industry interviews with driving proficient to pick up an understanding into BIM implementation in China. They found that contractors were receiving the innovation at a quicker rate than design experts. Designers has considered Bim as merely being ‘additional work’ within a fixed fee and so needed motivating forces. They likewise discovered that the Chinese industry had structural obstructions, for example, challenges with changing conventional medium. This discourage the use of collaborative BIM approaches.

Anyhow, a China BIM Union was formed in 2013 as part of the China Industry Technology Innovation Strategic Alliances by the Ministry of Science and Technology. The development of BIM standards is occurring and a draft of the Chinese National Standard for BIM Application has been completed and issued for comment.

2.3.10 India

According to (McGraw Hill, 2014), BIM implementation in India is in the beginning stages. Although, they note that the Indian construction market is currently valued at US$ 140 billion and predicted to rose to $620 billion by 2020 as there are many global companies are moving their operation to India. This will bring BIM into the market industry. They discovered that Bim was used on large project sectors such as hotels and airport by the massive construction companies. However, BIM is not being implement on a bigger scale. Hence the cost of the implementation is high due to the isolated ad-hoc use of BIM which is the industry requires more extensive training and development.

2.4 Malaysia Construction Industry Issues

Construction Industry Master Plan (CIMP) inscribed the issue of ineffective in the construction industry. Conflict of efficiency contributes to many related factors that worsened project outcomes. The industry faced conflict for the ineffective of project outcomes including time and cost overrun, poor productivity, low quality that leads to customer’s disappointment. Contractors financial aspect, contractor’s not proper planning, contractor's poor site management, deficient contractor experience, deficient client's finance and payments for completed work, problems with subcontractors, shortage in material, labor supply, equipment availability and failure, poor communication between stakeholders, and make mistake during the construction phase are the major caused of project delays beyond contract time (Sambasivan et al., 2007).

From many problems stated, the nature of construction industry that is specked became a major source of problems above. Many acknowledged construction industries as a specked industry. A linear sequence conducted by project players for the design and construction and construction process caused cracked throughout the project life cycle in the traditional procurement method. According (Evbuomwan et al., 1998), this method induced by the 'over the wall' syndrome that leads to the separation of the various parties and information in the construction project, enlarged cost due to design changes and not needed responsibilities claims, poor of actual project life-cycle analysis and poor communication of design reasoning and intent. Hence, the errand of AEC industry is to encourage to apply and implement technologies to improve the quality and productivity of the industry.

Building Information Modelling (BIM) is one of the innovative technologies in the planning, design, construction and facility management that needs to be utilized. The important features of BIM are that it supplied an object-oriented database that is made up of intelligent object, the 3D representation of integrated information and a relational database that is related. BIM implementation can be seen as one of the potential solvers to the problems occurred. Although implementing BIM could overcome the problems but the implementation remains at low level (Latiffi et al., 2013)(Zahrizan et al., 2014). Stakeholders need to be awake of the advantages of BIM and its future challenges in order to help implement BIM in construction process.

2.5 Challenges of BIM implementation

The implementation of BIM in AEC is testing task regardless of the advantages of BIM and requires dealing with specific obstructions before its fruitful implementation in AEC industry of any nation. These challenges or difficulties shift from nation to nation and are generally reliant upon the industry conditions. Research article of few previous researcher are shown in Table 2.2 below.

Table 2.2: Challenges and difficulties discovered by previous researchers

Author	Statements
(Pittman et al., 2004)	- Lack of clear consent as how to use or implement BIM - Bunch of issues around the implementation of BIM by the management - Impotence of various software as a whole to treat the operation - Inaccessibility of single record or treatise on BIM that teaches on its application or utilization - The need to standardize the BIM process and the guidelines for its implementation - Issue in regards to the advancement and task of BIM models among the AEC industries parties - Arranged into three categories of technical reasons: • The necessity that digital design data be computable • The demand for well-developed practical strategies for the purpose • The requirement for well-characterized value-based construction operation models to wipe out information ability issues
(Fischer et al., 2004)	Underlined two major reasons for slower implementation of BIM • Managerial • Technical
(Thomson & Miner, 2010)	The BIM related risks can be separated into two big categories 1. Process-related risk • Liability for any errors and contractual matter involves controlling charge of the data entry to the model

	• Lawful risk incorporates the absence of assurance of responsibility for BIM information • The requirement to assure it through copyright laws and other legal mediums. 2. Technology-related risk • The ability issues present extensive risks. • Licensing matter when team members are other than owner and architect • Absence of Bim standards for model combination and management by multidisciplinary teams.
(Ku and Taiebat, 2011)	BIM implementation difficulties by their study: • Big cost to implement BIM • Hesitance of different parties • Expectation to absorb information and absence of skilled work force • Insufficiency of contractual agreements • Shortage of collaborative work activities and modelling standards • Difficulties in interoperability
(S. Azhar et al., 2011)	Has discovered the following barriers in implementation of BIM\ • Ownership of BIM data • Control over whole of data and hold responsibilities for imprecise data • The matter concerning responsibility for proper technological interface among various software • The management issues concerning the use and implementation of BIM. • Absence of clear accord with respect to procedure to implement or utilize BIM

	• Necessity of standardized BIM process and guidelines for its implementation.

2.6 Advantages of BIM Implementation

BIM is a part of reducing costs, times and increased efficiencies (Azhar et al., 2008),(Sawhney, 2014),(Chougule et al., 2015). Hence, in the global environment sector, it is rising in popularity. It has impressed governments worldwide, especially in developed countries, and has led to strong steps towards increasing BIM implementation. In order to achieve a 20% reduction of capital costs and carbon costs resulting from the construction and operation of the environment sector, the UK Government has drafted the BIM strategy (Azhar et al., 2008)(Mcauley et al., 2012)(Sawhney, 2014).

In other words, through earlier access to the construction market, BIM can save the cost of design. The design time and cost can be halved (Yan et al., 2008). ' Half time at half cost ' does not just save money, it also reduces time to market. In addition to enhancing the technology, BIM changes the design and construction process. (Yan et al., 2008) said that the Modelling of Building Information provides accessible simultaneous information on project performance and project economic aspects in the operating phase. BIM leaves a trail of digital documents resulting from operational transformations and developments. Most BIM users believe it is possible during the entire operating phase to reduce dependency on human resources.

It can enhance project coordination and communication with both parties by adopting BIM in the development process. This applies to the staff team, where everyone can better understand the project. It enables colleagues to better understand this initiative (Becerik-gerber et al., 2010)(Jr, 2007). Many researchers and industry professional have highlighted the potential advantages of BIM implementation. From AEC main stake holder’s point of view, these potential advantages can be widely classified into the three categories of Owners, Designers and Contractors:

Meanwhile (Eastman et al., 2011) summarized the following benefits of BIM for project owners:

1. Early design assessments ensuring that the project requirements are met
2. Evaluation of building performance and maintainability by operations simulation
3. Reliability in cost estimates and reduction in quantity of variation orders thus enabling low financial risks.
4. Generation of 3D renderings and walk-though animations enables better marketing strategies.
5. Complete information about building and its systems in a single file (Taiebat, 2011).

Following are some of the main benefits of BIM for project designers:

1. Better design by rigorously analyzing digital models and visual simulations and receiving more valuable input from project owners;
2. Advance predictions of environmental performance of building designs by early incorporation of sustainability features.
3. Visual and analytical checks enable better code compliance.
4. Early forensic analysis to graphically assess potential failures, leaks, evacuation plans.
5. Quick production of shop or fabrication drawings (Kymmell,2008)

The contractors and subcontractors can use BIM for the following applications (Hardin, 2009):

1. High profitability;
2. Better customer service;
3. Cost and schedule compression;
4. Better production quality;
5. More informed decision making;
6. Better safety planning and management.

CHAPTER 3

METHODOLOGY

3.1 Introduction

The methodology is the most dominant aspect in each study to obtain a satisfactory outcome study. This is because the objective of a study would be obtained if the method used is applied correctly and accurately. This thesis attempts to the study focuses on the identification and prioritization, the factors challenging the implementation of BIM in Malaysian construction industry. In this study, we will focus on the literature review such as paper, book, journal and websites and the questionnaire survey. The questionnaire will be based on Likert's scale to collect the opinion of the respondent. This chapter will be explained in detailed on data collection technique, Likert's scale and data analysis.

3.2 Data Collection

For the data collection a set of questionnaires are prepared which consist of two sections. 100 respondents are targeted for the questionnaires and will be distribute by hand, e-mail and link using online survey. The target respondent are contractor, consultant and client. The details of company and total numbers of respondent were collected through internet. Data obtained from the questionnaires will be analysed with an appropriate method which may result in the successful of the research.

3.3 Likert Scale

The development of Likert scale is established into the purpose of the research that employs questionnaire. The intention of the questionnaire research is to understand about the opinions or perceptions of respondent related with single ‘latent’ variable (phenomenon of interest). This ‘latent’ variable is expressed by several ‘manifested’ items in the questionnaire. Respondents specify their level of agreement or disagreement from the likert scale provided. The bigger range of decisions provided more freedom to the respondent to pick the correct one as opposed to pick close-by choice. Often five ordered response range are used. However, some practitioners recommend the use of 7- and 9-point scales which add additional granularity. Sometimes a 4 point or other even number scale is used to produce a forced choice measure where no indifferent option is available. For this research, the Likert scale will be used in the questionnaire in order to collect the opinion from the respondent. The likert scale ranged between 1-5 ordinal scale will be used and are described as the Table 3.1 below.

Table 3.1: Likert Scale Index

1	2	3	4	5
Very Unimportant	Unimportant	Neutral	Important	Very Important

On the one hand, there’s a chance that some respondent might simply use the “neutral” choice as a way to skip the question altogether, meaning they do not provide any valuable feedback or opinion regarding the question.

3.4 Questionnaire Design

A questionnaire survey is designed based on the objective. which is factor that causes delays in construction project and the method on overcome delays in construction project. A questionnaire survey is developed to get the opinion and understanding from the experienced respondents regarding to the construction delays problem. The questionnaires are all classified into 2 sections:

a) SECTION A: Respondent background

b) SECTION B: Factors that challenges implementation of BIM

3.4.1 Section A: Respondent Background

In this section, we are trying to obtain the respondents' information. The questionnaire includes:

- Respondent company & location
- Respondent contact information
- Total employees of the respondent company
- Company discipline
- Period of working experiences
- Job titles of the respondent in the company
- BIM software that used by company
- BIM application that used by company

3.4.2 Section B: Factor That Challenge the Implementation of BIM

This section is designed to evaluate the factor that challenges the implementation of BIM in any countries AEC industry from the previous literature review. The questionnaire is mainly based on Likert's scale of 5 ordinal measures from 1 to 5 according to level of contributing. The factors were separated among each group criteria which are from Management, People, Process and Technology. The table below shown the factors for each group criteria.

3.4.2.1 Management Criteria

The Table 3.2 show 8 factors in term of the Management criteria from the international review of factors challenging in implementation of BIM in AEC industry.

Table 3.2: Management Criteria Factors

No:	Criteria Factors:
M01	Reference to legal or contract issues
M02	Management do not have a clear vision and missions for BIM implementation
M03	Management do not have the ability to motivate people
M04	Lack of businesses desire to change to BIM processes/ or against change
M05	Lack of case study evidence of the financial benefit of BIM
M06	Small businesses lack the resources to implement BIM fully
M07	No continuous commitment and support from the management
M08	Issues for collaborating with multiple Stakeholders

3.4.2.2 People Criteria

The Table 3.3 show 10 factors in term of the People criteria from the international review of factors challenging in implementation of BIM in AEC industry.

Table 3.3: People Criteria Factors

No:	Criteria Factors:
H01	Fear of the unknowns of BIM will lead to failure
H02	Ability to use multiple software
H03	Time needed for hiring people to use BIM
H04	Cost of training people to use BIM
H05	Appropriate/efficiently trained staff
H06	People are reluctant to move from the traditional method/what they have now is good enough
H07	Not clearly defined roles and responsibilities for BIM Administor
H08	Not clearly defined roles and responsibilities for BIM Modeller

H09	Not clearly defined roles and responsibilities for Head of Change
H10	Some believe BIM is not suitable for their projects

3.4.2.3 Process Criteria

The Table 3.4 show 10 factors in term of the Process criteria from the international review of factors challenging in implementation of BIM in AEC industry.

Table 3.4: Process Criteria Factors

No:	Criteria Factors:
P01	Procedure to recognize who owns data/ components used
P02	Not clear to identify copyright protection for ownership of data
P03	No roles to discover who is responsible to manages data entry
P04	No rules to discern the person in charge for inaccuracies and errors
P05	Not know who is responsible for maintaining and updating model
P06	No merit to determine who is allowed access and use of the BIM info/product
P07	No standard for Contractual BIM document
P08	Insurance carriers have no policy to insure for aspects BIM
P09	More time needed to send and receive back files between stakeholders
P10	No official standard or process to evaluate the use of BIM

3.4.2.4 Technology Criteria

The Table 3.5 show 7 factors in term of the Technology criteria from the international review of factors challenging in implementation of BIM in AEC industry.

Table 3.5: Technology Criteria Factors

No:	Criteria Factors:
T01	Software license and update cost

T02	Information lost between different software
T03	Complexity of BIM
T04	Cost of hardware
T05	Compatibility issues between Software
T06	Require competent quality hardware
T07	Lack of collaborative work activity and modelling standards

3.5 Pilot Study

A pilot study is one of the essential stages in a research project. A pilot study can be defined as a ‘small study to test research protocols, data collection instruments, sample recruitment strategies, and other research techniques in preparation for a larger study. All questionnaires should initially be piloted, completed by small sample of respondents. After modifying the questionnaire according to the supervisor advice and before collecting the final data from the whole sample, a pilot study is accomplished and three copies of the questionnaire are distributed to lecturers. The purpose of this step is to discover if the questions are well understanding able or not, also to find out any problem that may raise in filling the questionnaire. From the pilot study it appears that questions are generally clear. However, it seems some respondents find difficulties in understanding some questions and the question need to be revised back. Therefore, the questions will be modified to be clearer.

3.6 Data Analysis

All the data taken as a result of the interview will be sorted, organized and distributed based on the questions. In order to achieve the objectives, data analysis of the information gathered will be divided into two parts of analysis which is initial and detailed analysis. Preliminary analysis conducted on the data about respondent’s background and general information whereas the detailed analysis involved the analysis of the data necessitate for the purpose of reaching the research objectives.

In general, the data collected from the questionnaire distributed was analysed using “Relative Importance Index” (RII). This technique has been used by Al-Hammad *et.al.* (1997) in the same context of application. It is significant to know that the RII method was to determine the average response of the participants for each criteria. The RII method was calculated using the following formula in Figure 3.

Relative Importance Index = $\frac{\sum w}{AN} = \frac{5n_5 + 4n_4 + 3n_3 + 2n_2 + 1n_1}{5N}$

Where w is the weighting given to each factor by the respondent, ranging from 1 to 5. For example, n_1 = number of respondents for Little Important, n_2 = number of respondents for Some Important, n_3 = number of respondents for Quite Important, n_4 = number of respondents for Important, n_5 = number of respondents for Very Important). A is the highest weight (i.e. 5 in the study) and N is the total number of respondents. The relative importance index ranges from 0 to 1 (Tam and Le, 2006).

Figure 3.1: Average Method Formula

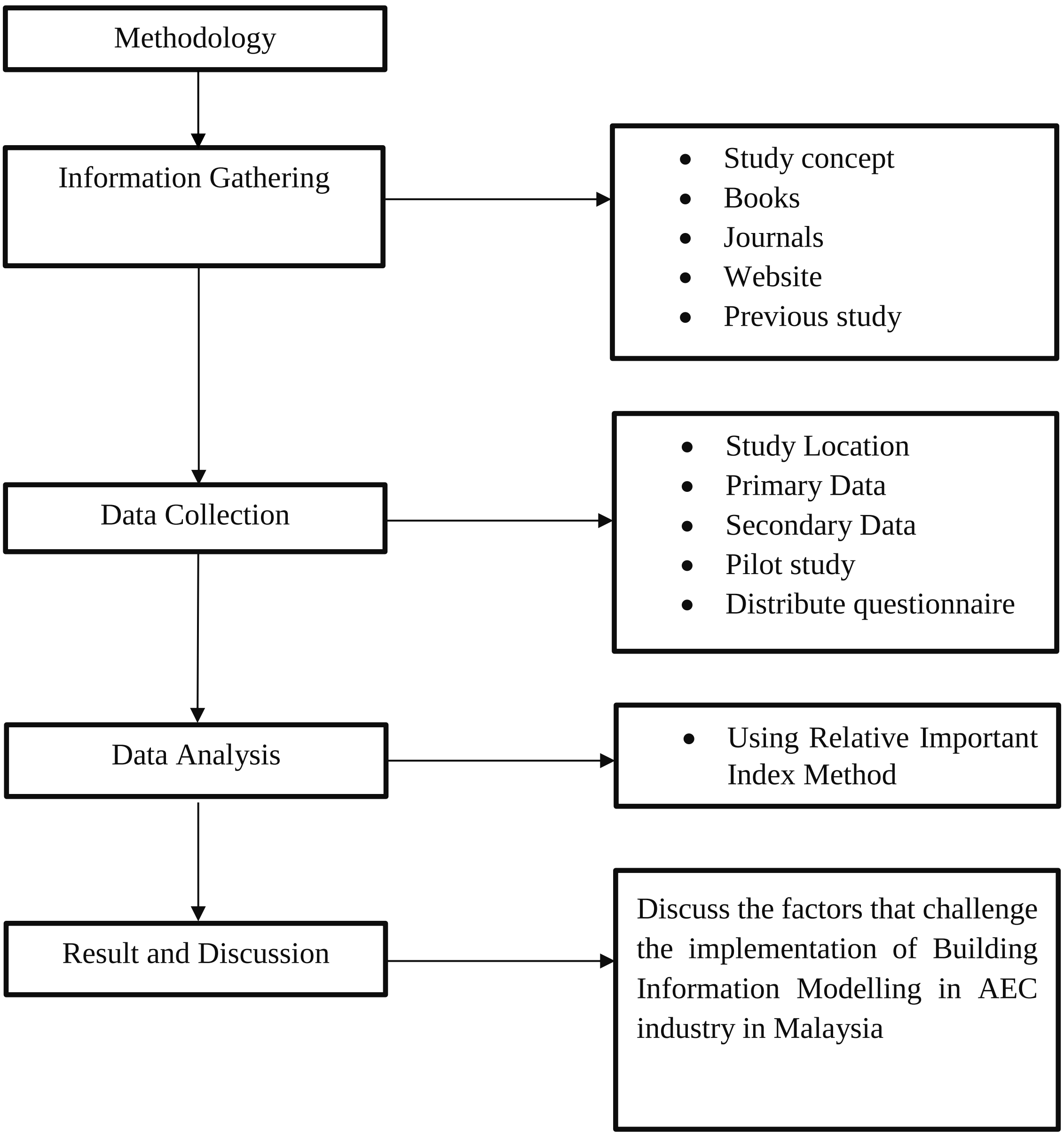
To determine the degree of importance in this study the classification of the rating scales the classifications of the rating scales have been used are as follows:

Table 3.6: Category scale in priority

Scales	**Categories**	**Average Index (x)**
1	Very Unimportant	$1.00 \leq X < 1.50$
2	Unimportant	$1.50 \leq X < 2.50$
3	Neutral	$2.50 \leq X < 3.50$
4	Important	$3.50 \leq X < 4.50$
5	Very Important	$4.50 \leq X \leq 5.00$

The data collected from the questionnaire that also called quantitative data were analyzed using Microsoft Excel. As a spreadsheet, Excel can be used for data entry, manipulation and presentation but it also offers a suite of statistical analysis functions and other tools that can be used to run descriptive statistics and to perform several different and useful inferential statistical tests that are widely used in research. Finally, the final analysis can be presented in the form of graphs, tables, pie charts etc so that it is more attractive and easily to understand.

3.7 Research Methodology



CHAPTER 4

RESULTS AND DISCUSSION

4.1 Introduction

This chapter will explain the finding of data collecting and also data analysis in order to achieve all the objectives. It involves treating, managing, and analyzing of all information gathered in previous phases particularly in data collection. The data was collected through the questionnaire that conducted based on the objective of study.

4.2 Study on BIM Implementation in Malaysia

Building Information Modeling (BIM) is a comparatively new era in the construction sector and seldom utilized in Malaysia's local construction. It is a new emerging approach to design and construction that enables the building process to be digitally represented (Baba, 2010). BIM is a virtual design and construction process and practice over its entire lifecycle (Hergunsel, 2011). It is not only a software but also a 3D construction design that arranges and analyzes all operating data before the actual construction is done. BIM has proven to be a useful technology in building, allowing practitioners to reduce potential risks and succeed in completing a project. From planning to operation, BIM could be used at every building phase. The implementation of BIM is, unfortunately, very slow in the Malaysian construction industry.

The human and technical hurdle, known as the internal and external hurdle, are responsible for this low implementation. It is very important to acknowledge hurdles to the implementation of BIM and develop strategies to deal with those hurdles to a successful implementation of BIM in buildings.

The Construction Industry Development Board (CIDB) has suggested the obligatory use in some of the private sector projects of Building Information Modeling

(BIM) by 2020. Datuk Ahmad Asri Abdul Hamid, the CEO of CIDB said that Malaysia was set to announce the fourth industrial revolution 4.0 and motivated industry leaders to take automated implementation. In the public sector, a project costing RM 100 million or so would have to use the BIM system from this year. Asri said that only a few massive companies were using BIM in Malaysia

4.3 Responses to Questionnaires

The structured questionnaire based on the literature review is presented in Appendix. The questionnaire has been distributed to random construction industry companies to seek the views from the construction expertise such as architect, engineer, contractor, developer, consultant and others. This questionnaire form should be answered by the expertise to ensure the authenticity of the data obtained. Table 4.1 shows the list of the respondent's selected companies. The number of respondents collected from the questionnaire is 70.

Table 4.1: List of companies selected

No	Company's Name	No	Company's Name
1	Gamuda Bhd	6	IJM Land Bhd.
2	Bina Darulaman Bhd.	7	DKLS Construction Sdn. Bhd.
3	EUPE Corp. Bhd.	8	Belati Wangsa (M) Sdn Bhd
4	Builtech Project Management Sdn. Bhd.	9	Conlay Construction Sdn. Bhd.
5	PLB Land Sdn. Bhd.	10	Franky Construction Sdn. Bhd.

In the selection of a company to ask for a view, some criteria are needed to ensure the effectiveness of the views that will affect the results to be made at the end of this study. All of the above companies are selected based on their credibility and success in project success since the establishment of the company. As an addition, companies that have been listed above are some well-known companies in their respective states.

4.3.1 Background of Respondents

A total of 70 respondents were selected for this research. The background of each respondents taking into consideration are the respondents' occupation, the discipline of the company belongs, the number of workers at the company and the duration of their involvement in construction industry.

4.3.1.1 Occupation of Respondents

The respondents' occupation data is described in this section. The occupation of the respondents was filled from a single box answer. So, the answer come from various of name of their job titles such as Project Manager, Principal Engineer, BIM Coordinator, BIM Manager and Director. Most of the respondent come from Grade 5 to Grade 7 based on ASCE Guidelines for Engineering Grades that have the working experiences of 5+ years period. There are also non-BIM user respondents which are contractors, project manager and site engineers.

4.3.1.2 Company's Employee

Number of employees in the respondent's company does not being a main influence in the result discussion yet still it can be described as more employees in the company means the company is a massive company that involved in this industry. The small business company could be one of the reasons that BIM is not implement as small business company just take the projects that are not very complicated to use the BIM technology. A specify overview of the number of employees in the company is presented in Table 4.2 and Figure 4.1.

Table 4.2: The demographic employee number of the respondent's company

Occupation	Frequency, *n*	Percentage, %
0-4	0	0
5-19	2	3

20-40	13	19
40-100	21	30
More than 100	34	49
Total	**70**	**100**

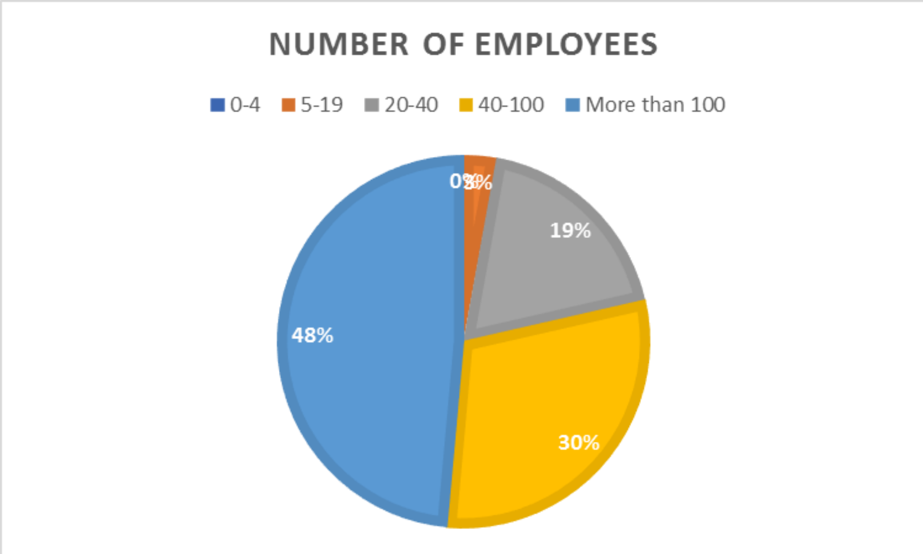


Figure 4.1: Number of employees

Figure 4.1 shown that the number of employees that have ‘more than 100’ workers are the highest percentages of 48% while followed by ’40-100’ workers that out turn 30% in the result. Although this two group scored the highest percentages, certain of the company still not implement BIM in their project construction. Next, number of employees that have ’20-40’ outcome the third highest percentages which is 19% or 13 respondents from the total respondents.

Shockingly, there are some company that consisted of ‘5-19’ workers have implemented BIM in the company project. The company might be the subsidiary company that taking part in the big construction project.

4.3.1.3 Discipline of the Company

In this part, the discipline of the company will contribute a lot in the result data because their scope of works could relate a lot in the implementation of BIM in the construction industry. The respondent company's discipline is illustrated in this section. A detailed overview of the experience in the construction industry of the respondents is presented in Table 4.3 and Figure 4.2.

Table 4.3: The demographic occupation of the respondents

Occupation	**Frequency, *n***	**Percentage, %**
Architect	22	31
Engineer	16	23
Contractor	13	19
Developer	11	16
Others	8	11
Total	**70**	**100**

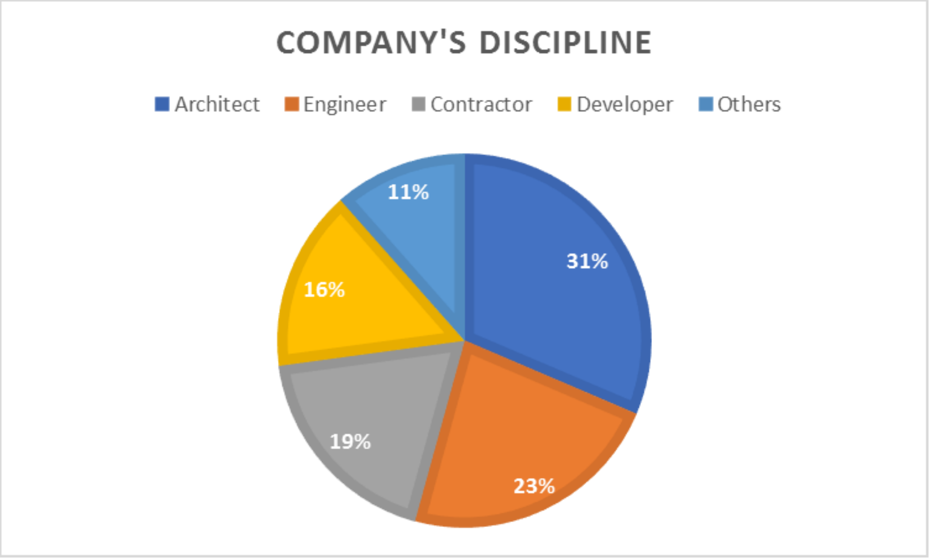


Figure 4.2: Respondent's Company Discipline

Figure 4.2 represented the occupation of respondents that involved in construction industry. The figure shows that 26% of the respondents are architect, followed by the respondents from engineer which is 17% respondents. Contractor takes third place of the majority respondents with 19%. Next, the percentage followed by the developer for just

16% from the respondents. For the least percentage of the respondents are others which at 11%. Architects and engineers become the majority because these two parties are available in all types of construction companies and always in charge of BIM compared to other parties such as developers and others.

Despite that, majority of the respondents are the parties that directly involves on site which will influence the result a lot for this study. The experience possess by the respondents may help in providing a better understanding of this matter and in better position in giving much precise answer required to the questionnaires form. In this study, it clearly demonstrates the feasibility of the respondents' characteristics which provide an opinion and thus provide an effective answer to this implementation issue.

4.3.1.4 Experience in The Construction Industry

In this part, the experience will play an important factor in gaining experience in the period of implementation of BIM. In addition, the longer the individual is involved with the construction sector, the more they know about the situation will change time by time, which is likely to contribute to know the factors challenging the implementation in this AEC industry. The respondents' experience in the construction industry data are described in this section. A detailed overview of the experience in the construction industry of the respondents is presented in Table 4.4 and Figure 4.3.

Table 4.4: The demographic experience of the respondents

Years of Experience	**Frequency, *n***	**Percentage, %**
Less than 1 year	0	0
1-5 years	24	34
6-10 years	19	27
11-15 years	9	13
More than 20 years	18	26
Total	**70**	**100**

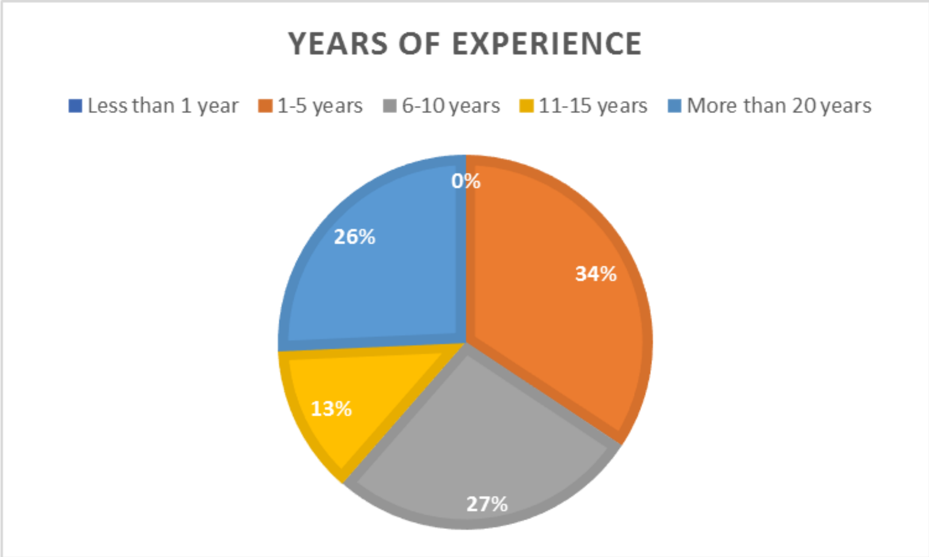


Figure 4.3: Respondent's years of experience

Figure 4.3 show the years of experience of the respondents in construction industry. Most of the respondents experienced 1 to 5 years in construction industry with 34% majority followed by 6 to 10 years of experience which is 27% of the respondents. Next, more than twenty years of experience was on the third place which at 26%. Last but not least, the respondent from experience of 11-15 years working are behind with just 13% respondents. The data shows that expertise has influenced the percentage of the respondents thus provided the best answer for this research. The majority comes from respondents experienced 1 to 5 years due to the positions that will require much more experienced to be held.

However, this percentage also reflected the current phenomenon of local industry, which there were large number of young practitioners have been graduated in current years to meet the vast human demand, and they sat on high positions in the organizations. This research focuses on more experienced people in providing insights and provides the best answer for this research.

4.3.1.5 Location of Respondents

Respondent's location is not a major factor in influencing the validity of the answer but it can play a role in the possibility of involvement of an individual that works in a state with a high number of high cost projects. The views of individuals which directly involved with high cost projects are meaningful to this research. The respondents' location data is described in this section. A detailed overview of the location of the respondents is presented in Table 4.5 and Figure 4.4.

Table 4.5: The demographic location of the respondents

Location	**Frequency, *n***	**Percentage, %**
Kuala Lumpur	19	27
Selangor	17	24
Penang	11	16
Perak	10	14
Kedah	10	14
Pahang	3	4
Total	**70**	**100**

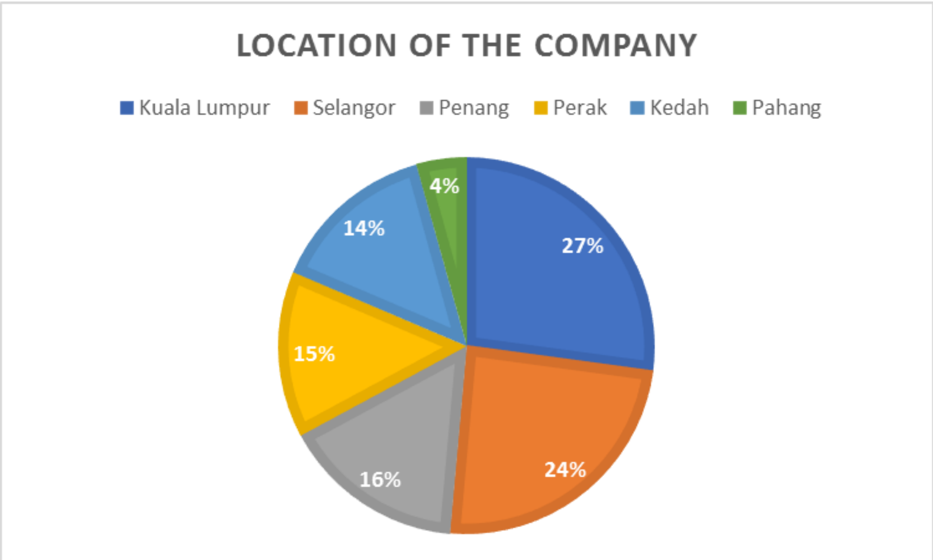


Figure 4.4: Respondent's location

Figure 4.4 show the location of the selective respondents. Questionnaires are distributed to Selangor, Kuala Lumpur and all over state in North Malaysia. The majority of the respondents are from Kuala Lumpur, Selangor and Penang with 19, 17 and 11 respondents or 27%, 24% and 16% respectively. This is followed by Perak respondents, with 10 respondents representing 14% in this study, which is same number of respondents from Kedah with 10 respondents. The least percentage of respondents came from Pahang with 4% or 3 respondents.

Most of the respondents came from huge company that has involved with varieties of the projects. Therefore, the views obtained may the views of those who have been involved with the massive projects.

4.4 Factors Challenging the Implementation of BIM

The factors challenging in implementation of BIM in this study were identified from the previous researches from international reviews. The factors were separated among each group criteria which are from Management, People, Process and Technology. The factors will be ranked based on relative importance index (RII) as mentioned in the methodology in chapter three. A further discussion in the following paragraph justified the group of the factor criteria.

4.4.1 Management Criteria

Some of us aren't ready to implement BIM. This is not true. Some people have been willing to implement BIM-friendly processes, but company management have been the major challenge that they have never been able to overcome. BIM works much better if all associated with the project can readily share and cooperate with information. In the context of data security, responsibility and dispute concerns, contracts generally prohibit the sharing of information. It should therefore be understood that innovative solutions are necessary not only to protect companies but also to encourage them to work around each other.

Companies can further protect themselves by applying filters to the information they share; building plans could be shaded green, yellow, or red, for example, to indicate whether the information is final, provisional, or incomplete. By collaborating with stakeholders, all parties can agree upon definitions, processes, policies, and parameters at the start of every project. Doing so will reduce risk while streamlining the workflows that BIM relies on.

Companies can further insulate themselves by using the personal data they openly discuss through filters; for example, the building plans might be shaded green, yellow, or red to indicate whether the information is final, executive, or incomplete. All parties can agree on concepts, procedures, practices and requirements at the beginning of each project by cooperating with the stakeholders. This will reduce the likelihood by simplifying BIM's business processes.

The frequency analysis of management criteria has been performed on the data and the following results have been achieved and shown Table 4.6 and Figure 4.5:

Table 4.6: Management Criteria

Criteria Factors	RII	Frequency (%)
M01: Reference to legal or contract issues	0.808	13.19
M02: Management do not have a clear vision and missions for BIM implementation	0.694	11.33
M03: Management do not have the ability to motivate people	0.717	11.70
M04: Lack of businesses desire to change to BIM processes/ or against change	0.694	11.33
M05: Lack of case study evidence of the financial benefit of BIM	0.814	13.29
M06: Small businesses lack the resources to implement BIM fully	0.888	14.50
M07: No continuous commitment and support from the management	0.814	13.29
M08: Issues for collaborating with multiple Stakeholders	0.697	11.38
Total	**6.126**	**100**

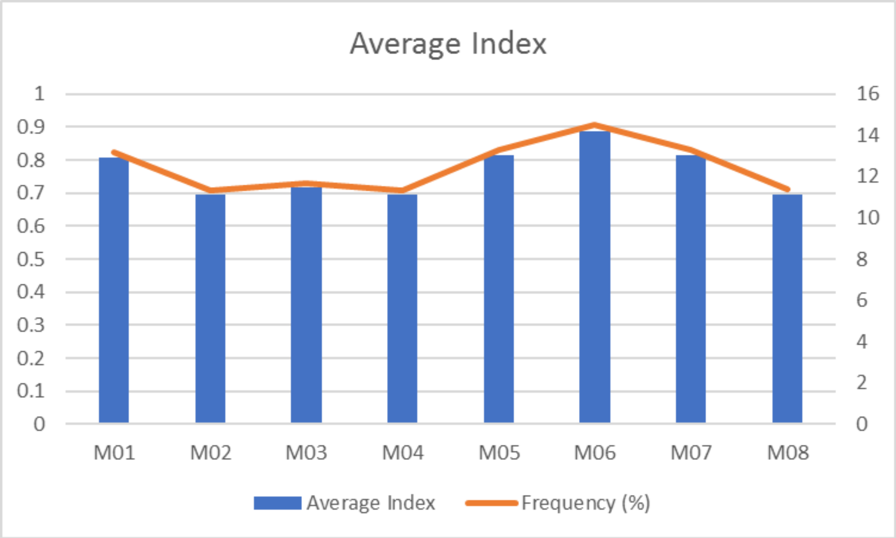


Figure 4.5: Management Criteria Index

Figure 4.5 show that factors challenging to implement BIM from M06 which is ‘Small businesses lack the resources to implement BIM fully’ scored the highest average index. Small business means small company. Hence, small company will lack of resources because they only deal with small project business that not using the BIM technology.

Next, the second highest average index score are share by the M05 and M07 which are ‘Lack of case study evidence of the financial benefit of BIM’ and ‘No continuous commitment and support from the management’ respectively. These are best believed that the certain company management does not support the new BIM technology as the management still not aware about the benefits of BIM. As an example, one of the benefits is cost saving so the management need to discover more how much the financial budget that they could save if they start to implement this BIM technology. Meantime, the third highest average score is factors M01 which means ‘Reference to legal or contract issues’.

Lastly, the lowest average index scored are also share by M02 and M04 which are ‘Management do not have a clear vision and missions for BIM implementation’ and ‘Lack of businesses desire to change to BIM processes or against change’ respectively. These illustrated that the management still do not have a clear understanding on how BIM is functioning and the vision and mission of BIM implementation. This could lead to their low ambition to change to use BIM technology.

4.4.2 People Criteria

To rise to the challenge in implementing BIM, an organization requires the entire team to understand its benefit and to start taking the change into consideration. It is the human elements, and therefore the processes and policies, which have the potential to drag progress down.

It is important to acknowledge that your team always starts cultural change offline. The development of a strong relationship with professionals, in-house teams or a supplier of design support solutions has always been one of the key elements when technological changes are undertaken.

The frequency analysis of management criteria has been performed on the data and the following results have been achieved and shown Table 4.7 and Figure 4.6:

Table 4.7: People Criteria

Criteria Factors	RII	Frequency (%)
H01: Fear of the unknowns of BIM will lead to failure	0.811	9.42
H02: Ability to use multiple software	0.917	10.66
H03: Time needed for hiring people to use BIM	0.945	10.98
H04: Cost of training people to use BIM	0.888	10.32
H05: Appropriate/efficiently trained staff	0.914	10.62
H06: People are reluctant to move from the traditional method/what they have now is good enough	0.805	9.36
H07: Not clearly defined roles and responsibilities for BIM Administor	0.780	9.06
H08: Not clearly defined roles and responsibilities for BIM Modeller	0.808	9.39

H09: Not clearly defined roles and responsibilities for Head of Change	0.940	10.92
H10: Some believe BIM is not suitable for their projects	0.797	9.26
Total	**8.605**	**100**

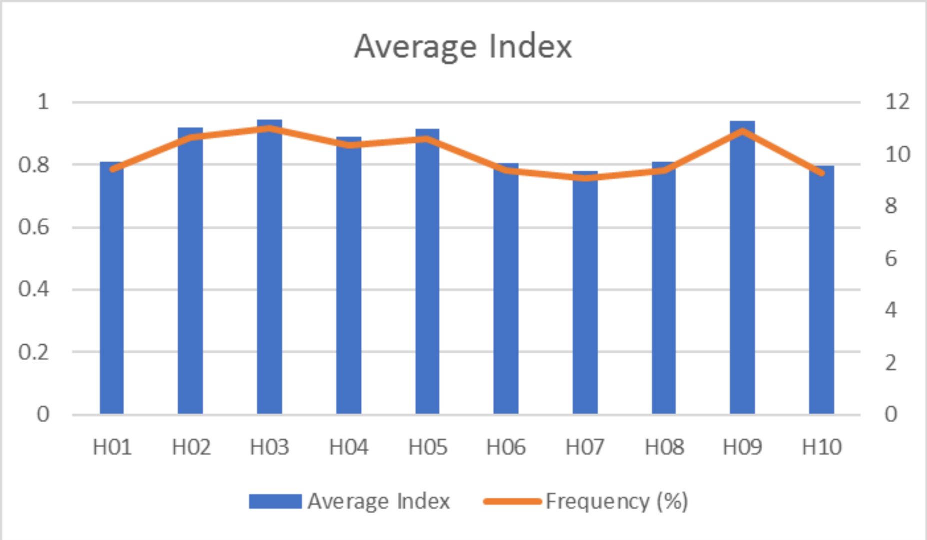


Figure 4.6: People Criteria Index

Figure 4.6 display that the highest factors of challenging the implementation of BIM is H03 which is 'Time needed for hiring people to use BIM'. BIM is the new game changer as an innovation solution. But there is a good demand for new skilled workers, just like with any new technology. In order to be BIM specialist, more time needed to be a great skilled worker as they will learn a lot about BIM technology. Best believes the time needed to be a BIM specialist is 6 months and above. Most likely candidates to be BIM specialist should come from construction background as it is mostly practical construction, project management and communication.

Next, second highest average index resulted is H09 which is 'Not clearly defined roles and responsibilities for Head of Change'. Head of Change need to know all their job scope clearly as they will manage tasks like meeting customers and contractor, ensuring that the models are correctly executed, detecting clashes and ensuring that there are no mistakes or errors. Then, the factors H02 which means 'Ability to use multiple software' is the third highest score average index in the term of people.

4.4.3 Process Criteria

Within a single virtual template BIM can be seen as a virtual process which covers all aspects, areas and systems of an establishment that allows all team members (owners, architects, engineers, contractors, sub-contractors and suppliers) to cooperate more accurately and efficiently than conventional processes. Whilst the model is being developed, team members continuously improve and adapt their segments to project configuration and design changes so that the model can be as accurate as possible before the project breaks ground physically (Carmona and Irwin, 2007).

The frequency analysis of management criteria has been performed on the data and the following results have been achieved and shown Table 4.8 and Figure 4.7:

Table 4.8: People Criteria

Criteria Factors	RII	Frequency (%)
P01: Procedure to recognize who owns data/ components used	0.809	9.86
P02: Not clear to identify copyright protection for ownership of data	0.917	11.17
P03: No roles to discover who is responsible to manages data entry	0.769	9.37
P04: No rules to discern the person in charge for inaccuracies and errors	0.845	10.29
P05: Not know who is responsible for maintaining and updating model	0.908	11.06
P06: No merit to determine who is allowed access and use of the BIM info/product	0.814	9.92
P07: No standard for Contractual BIM document	0.820	9.99

P08: Insurance carriers have no policy to insure for aspects BIM	0.791	9.64
P09: More time needed to send and receive back files between stakeholders	0.745	9.08
P10: No official standard or process to evaluate the use of BIM	0.791	9.64
Total	**8.209**	**100**

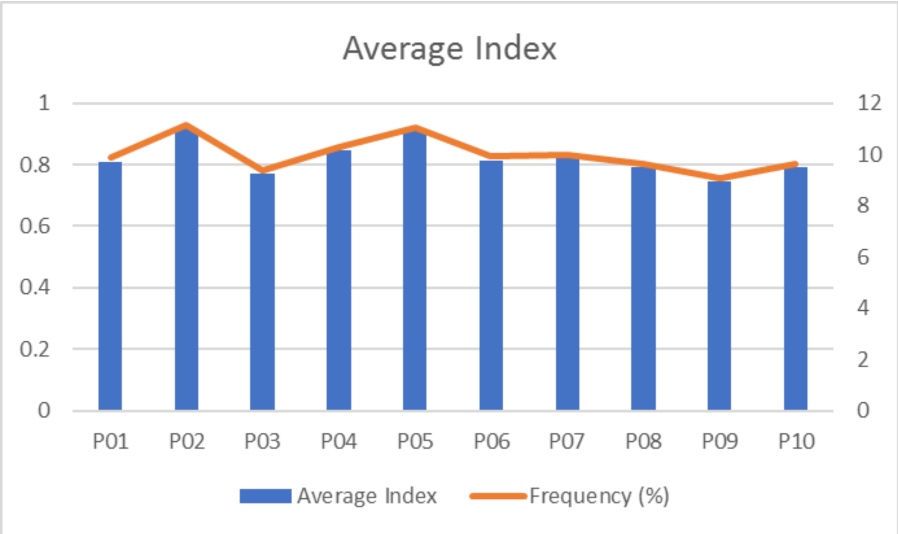


Figure 4.7: Process Criteria Index

Figure 4.7 exhibited that the highest factors of challenging the implementation of BIM in criteria of Process is P02 which means 'Not clear to identify copyright protection for ownership of data'. The data information that shared from stakeholders are confidential and need to be protected. The owner might feel obligated, for instance, to be the owner, when the owner pays for the design. However, if team members provide open source project information, their open source information must also be protected. Hence, the question of data ownership is not simple, it calls for a unique solution for each project, depending on the needs of the parties involved. The aim is to avoid inhibitions or prohibit participants from fully realizing the potential of the model (Thompson, 2001).

‘Not know who is responsible for maintaining and updating model’ from factor P05 is the second highest scored average index. This is assuming liability for refreshing structure data model information and guaranteeing its precision involves a lot of risks. Requests for complicated BIM user’s compensation and a limited range of designer guarantees and liability disclaimers are key negotiating points which must be resolved prior to the application of BIM technology. Meanwhile the third highest average scored is factors P04 which define ‘No rules to discern the person in charge for inaccuracies and errors’.

The lowest average index scored is the factor P09 which is ‘More time needed to send and receive back files between stakeholders’. This process required a lot of cooperation and discipline as the files data need to be shared following the time management of the project.

4.4.4 Technology Criteria

From the technological point of view, a project simulation is a building information model comprising 3D models of project components with connections to all necessary information related to project planning, design, construction or operation as shown in Figure 1. The BIM technology comes from the parametric modeling technique oriented towards objects. The term parametric defines a procedure in which an aspect is changed to preserve a pre-established relationship with a contiguous aspect or operation (e.g. a door attached to a wall).

The main difference among the BIM technology is that it outlines a building from 3D independent views, such as plans, sections and heights. The latter defines a building. To edit one of these opinions, all other views must be examined and updated, which is one of the main reasons of poor documentation.

The frequency analysis of technology criteria has been performed on the data and the following results have been achieved and shown Table 4.9 and Figure 4.8:

Table 4.9: Technology Criteria

Criteria Factors	RII	Frequency (%)
T01: Software license and update cost	0.905	15.21
T02: Information lost between different software	0.789	13.26
T03: Complexity of BIM	0.823	13.82
T04: Cost of hardware	0.814	13.68
T05: Compatibility issues between Software	0.897	15.07
T06: Require competent quality hardware	0.840	14.12
T07: Lack of collaborative work activity and modelling standards	0.883	14.84
Total	**5.951**	**100**

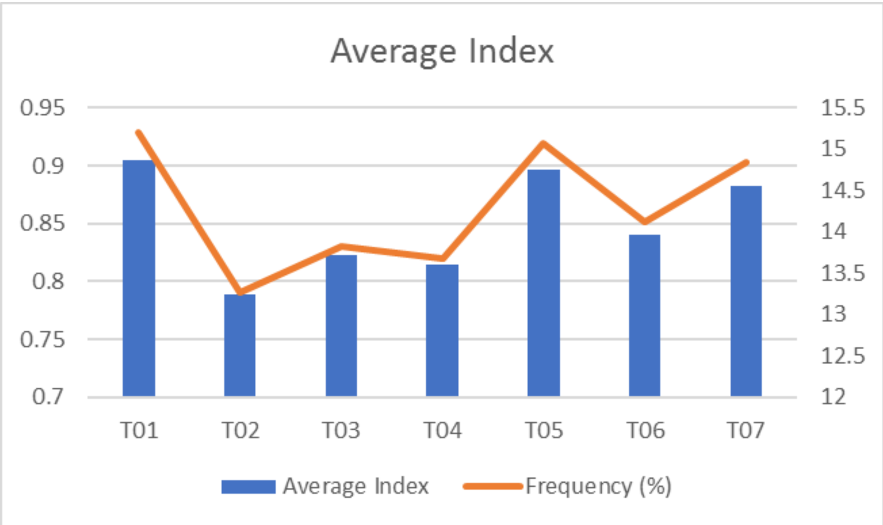


Figure 4.8: Technology Criteria Index

Figure 4.8 shows that the highest average index scored in the criteria of Technology is T01 which is 'Software license and update cost'. Cost is one of the major challenges in implementing BIM technology as the license of software and tools of BIM need to be bought. Even though these costs might be drastically counterbalanced by productivity and schedule gains, they are still a cost that someone on the project team will sustain. Therefore, the cost of implementing BIM must be paid before BIM technology can be fully used (Thompson and Miner, 2007).

Meanwhile, the second-high average value scored is factors T05 which means ‘Compatibility issues between Software’ and third is factors T07 that define ‘Lack of collaborative work activity and modelling standards’.

4.5 Summary

By conducting analysis and discussion in this chapter, various discoveries and results are obtained. The pre-defined objectives are accomplished by focusing to answer the research question during the analysis and discussion. The problems facing by AEC industry professional that contributes to the challenges of implementation of BIM and point of view from experts about regarding this matter were distinguished, ranked and analyzed. From a sum of 35 problems from all criteria factors that contributes to the challenges in implementation of BIM, five best most critical problems have been distinguished. Thus, the following chapter, which is the final chapter, will include end, and recommendation for this study, and recommendation for further research on this topic. Problems that exist amid the study and the limitation will also be described in the following chapter.

CHAPTER 5

CONCLUSION

5.1 Introduction

This chapter concludes the overall study that has been conducted. This chapter discusses all the objectives that has been achieved through previous analysis and discussion chapter. Therefore, in this final chapter of the research project paper, the overall conclusion and summary of the study will be made. Besides that, any recommendation for this study as well as recommendation for pursuing this study will also be described in this chapter.

5.1 Conclusion of the Findings

The followings are the conclusions derived from the literature study and questionnaire survey conducted.

5.1.1 To collect and analyses data from company respondents

The data collection about the factor of challenges in implementing in Malaysia have been collected from various type of respondent from various companies. the total respondents are 70 respondents only. The data have been concluded in demographic chart and have been explained in the previous chapter.

5.1.2 To puzzle out the factors that challenges the implementation of BIM in Malaysia AEC industry

Second objective has been achieved through literature review and questionnaire data obtained from the survey. From the literature review, about 35 factors of challenge facing by Malaysian AEC industry have been identified and arranged accordingly to their group of criteria. All these factors are shown in Chapter 2.

Hence, from the criteria of Management, the top 3 results for the frequency of index of occurrence based on priority are factors M06 which is ‘Small businesses lack the resources to implement BIM fully’. Followed by M05 and M07 which are ‘Lack of case study evidence of the financial benefit of BIM’ and ‘No continuous commitment and support from the management’ respectively.

Next, the top 3 factors for criteria of People are from factors H03 which is ‘Time needed for hiring people to use BIM’. Pursued by H09 and H02 which are ‘Not clearly defined roles and responsibilities for Head of Change’ and ‘Ability to use multiple software’ independently.

Then, from the criteria of Process, the top 3 results for the frequency of index are factors P02 which is ‘Not clear to identify copyright protection for ownership of data’. Followed by the factors P05 and P07 which are ‘Not know who is responsible for maintaining and updating model’ and ‘No standard for Contractual BIM document’ respectively.

Lastly, from the Technology criteria, the top 3 factors challenging in implementation of BIM are from factors T01 which means ‘Software license and update cost’. Pursued by factors T05 and T07 which are ‘Compatibility issues between Software’ and ‘Lack of collaborative work activity and modelling standards’ independently.

5.2 Limitation

When the research survey is conducted, there are many limitations occurred. Most of the limitation is normally happened and is new to let the researcher gaining more experiences.

5.2.1 Time limitation

The time frame to finished up the research is very limited and take so much time because the research is conducted by doing questionnaire survey. Time is needed to reached respondents that busy working and time needed to submit the answers.

5.2.2 Networking limitation

When the searching for respondents is done, to gain more respondent is difficult because some of the respondent refuse to give their networking.

5.2.3 Knowledge limitation

When the research is conducted, the expert is needed to gain more knowledge and get know about the research topic that related with the research. This step is very crucial to make sure that the research that had been done must be informative compared to the previous research. As the researcher have limited knowledge about the research topic, researcher has done doing reading of journal, research paper, books and all reading material that related to the research topic.

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APPENDIX A
QUESTIONNAIRE FORM SURVEY

QUESTIONNAIRE FORM FOR FOCUS GROUP VALIDATION WORKSHOP

Faculty of Civil Engineering & Earth Resources

Universiti Malaysia Pahang,

26300 Gambang, Pahang

Research Information Statement for The Final Year Project

CHALLENGE OF BUILDING INFORMATION MODELLING (BIM) IMPLEMENTATION IN MALAYSIA AEC INDUSTRY

Dear Madam/Sir,

My name is Muhammad Khairul Anuar Isa, currently a student at Universiti Malaysia Pahang, Pahang and doing this research under supervision of Dr. Ahmad Tarmizi Haron.

As part of the under-way Bachelor's Degree program, you are kindly invited to endorse my research findings on the research entitled Challenge of Building Information Modelling (BIM) Implementation in Malaysia AEC Industry. This research is conducted to identify the challenges that your company faced about implementation of BIM. Therefore, I am requesting for your kind cooperation in giving your time, experiences and thoughts by answering the questionnaire form provided. Your cooperation is most necessary as the deliverables of the case study could be valuable for both industry and academia.

Importance Definition

Within the context of this research, BIM is defined as a modelling technology and associated set of processes to procedure, communicate and analyze building information models (Eastman et al., 2008). Modelling technology within this context of research is referred to 3d parametric authoring tool and some examples are BoCAD, Tekla Structures, Revit Architectures and Structures, Bentley Systems.

Privacy Protection

All responses to this questionnaire would be kept closely confidential and will only be used for academic purposed only. Once an appropriate data collection be conducted, the questionnaire will be shredded away after use.

How will the information gained be used?

Unless requested, by default, once you have decided to participate, the anonymous data collected from your verbal and written contributions may appear in the Bachelor's

Degree thesis and other related publications such as local and international journal. However, no personal detail or details about the organization will be disclosed.

SECTION A: PERSONAL PROFILE

Company Name :
…………………………………………………………………………

Location :
…………………………………………………………………………

E-mail :
…………………………………………………………………………

Contact Number :
…………………………………………………………………………

1.1 How many employees do your company have?

0-4	5-19	20-40	40-100	More than 100

1.2 Which of the following discipline does your company belong to?

Architecture	Engineering	Contractor	Developer	Other (please specify) ……………………………

1.3 How long have you been working in AEC industry?

Less than a year	1-5 years	6-10 years	11-15 years	More than 20 years

1.4 Your current job titles?

………………………………………………………………………………………
…

1.5 Is your company currently using BIM tools as part of working process?

YES □ NO □ (please jump to section B)

1.6 Please circle the BIM software tools used by your company.

Revit Structure	Revit Architecture	Revit MEP	Bently Structure
BOCAD	Archicad	Tekla Structure	Naviswork
PDMS	Others (please specify): …………………………………………		

1.7 Please circle the BIM application used by your company.

Visualization	Drawing Automation	Automated Clash Check	Material Taking Off
Energy Analysis	Structure Analysis	Others (please specify): ……………………………………………	

SECTION B:

For the level of importance, please select the most appropriate answer by ticking one of the boxes for each criteria based on your **view and/or experiences** where;

1-Very Unimportant 2-Not Important 3-Neutral 4-Important 5-Highly Important

IMPLEMENTATION CHALLENGE		**LEVEL OF IMPORTANCE**				
		1	**2**	**3**	**4**	**5**
MANAGEMENT	M01: Reference to legal or contract issues					
	M02: Management do not have a clear vision and missions for BIM implementation					
	M03: Management do not have the ability to motivate people					
	M04: Lack of businesses desire to change to BIM processes/ or against change					
	M05: Lack of case study evidence of the financial benefit of BIM					
	M06: Small businesses lack the resources to implement BIM fully					
	M07: No continuous commitment and support from the management					
	M08: Issues for collaborating with multiple Stakeholders					

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IMPLEMENTATION CHALLENGE		LEVEL OF IMPORTANCE				
		1	2	3	4	5
PEOPLE	H01: Fear of the unknowns of BIM will lead to failure					
	H02: Ability to use multiple software					
	H03: Time needed for hiring people to use BIM					
	H04: Cost of training people to use BIM					
	H05: Appropriate/efficiently trained staff					
	H06: People are reluctant to move from the traditional method/what they have now is good enough					
	H07: Not clearly defined roles and responsibilities for BIM Administor					
	H08: Not clearly defined roles and responsibilities for BIM Modeller					
	H09: Not clearly defined roles and responsibilities for Head of Change					
	H10: Some believe BIM is not suitable for their projects					

IMPLEMENTATION CHALLENGE		LEVEL OF IMPORTANCE				
		1	2	3	4	5
PROCESS	P01: Procedure to recognize who owns data/ components used					
	P02: Not clear to identify copyright protection for ownership of data					
	P03: No roles to discover who is responsible to manages data entry					
	P04: No rules to discern the person in charge for inaccuracies and errors					
	P05: Not know who is responsible for maintaining and updating model					
	P06: No merit to determine who is allowed access and use of the BIM info/ product					
	P07: No standard for Contractual BIM document					
	P08: Insurance carriers have no policy to insure for aspects BIM					
	P09: More time needed to send and receive back files between stakeholders					
	P10: No official standard or process to evaluate the use of BIM					

IMPLEMENTATION CHALLENGE		LEVEL OF IMPORTANCE				
		1	2	3	4	5
TECHNOLOGY	T01: Software license and update cost					
	T02: Information lost between different software					
	T03: Complexity of BIM					
	T04: Cost of hardware					
	T05: Compatibility issues between Software					
	T06: Require competent quality hardware					
	T07: Lack of collaborative work activity and modeling standards					

Please suggest any other challenges (if any) in the implementation of BIM.

1. ……………………………………………………………………………….

2. ……………………………………………………………………………….

3. ……………………………………………………………………………….

4. ……………………………………………………………………………….

5. ……………………………………………………………………………….

-END OF QUESTION-