PERCEPTION ON THE IMPLEMENTATION OF BUILDING INFORMATION MODELLING (BIM) IN FACILITY MANAGEMENT (FM)

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DECEMBER 2022

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A research project submitted in partial fulfillment of the requirement for the degree of

Master of Business Administration
(Building Management)

Universiti Tunku Abdul Rahman

Faculty of Accountancy and Management

December 2022

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DECLARATION

I hereby declare that:

(1) This Research Project is the end result of my own work and that due acknowledgement has been given in the references to all sources of information be they printed, electronic, or personal.

(2) No portion of this research project has been submitted in support of any application for any other degree or qualification of this or any other university, or other institutes of learning.

(3) The word count of this research report is ______24274________________.

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Date: December 2022

ACKNOWLEDGEMENT

First and foremost, I would like to express my intense gratitude to my research project supervisor, Dr Sheelah A/P Sivanathan as she had given countless guidance, patience and willingness in sharing her knowledge all along during my research study period. Without her help, the project is not going to be completed with such smooth progress.

Moreover, I would like to give my sincere thanks to my family members, friends, course mates and colleagues for their support and motivation.

Credits must be given to all the researchers who have made a lot of efforts in researching on this topic, their findings are the seeds or sources to generate ideas and directions of this study. Needless to say, their findings are also the main supports and evidences in proofing the discussions in this study.

Nonetheless, my most sincere gratitude is dedicated to Universiti Tunku Abdul Rahman (UTAR) for providing me a chance and conduit to carry out this research study.

Finally, thanks a million to the respondents who willing to spend time to answer all the questions in the questionnaire. My heart will be always filled with appreciation towards every person who had contributed in this study.

DEDICATION

I would like to dedicate this research study to Dr Sheelah a/p Sivanathan as she had also put in a lot of efforts in assisting me to complete the research. Nonetheless, this must also dedicate to UTAR, the university with all the great facilities, personnel and teaching system in cultivating the researchers.

In addition, the dedication must be given to my beloved family members, friends, course-mates and colleagues for their unwavering support during my period of study.

Last but not least, this paper is dedicated to whoever involved in this study or related fields, with the hope that my paper would contribute to the whole world.

TABLE OF CONTENTS

LIST OF TABLES

Page

LIST OF FIGURES

Page

LIST OF ABBREVIATION

AEC	Architecture, Engineering and Construction
BIM	Building Information Modelling
FM	Facility Management
HTMT	Hetero Trait – Mono Trait
IFMA	International Facility Management Association
PEOU	Perceived Ease of Use
PLS-SEM	Partial Least Squares Structural Equation Modelling
PU	Perceived Usefulness

PREFACE

This research is submitted as a requirement to pursuit the postgraduate of Master of Business Administration (Building Management) in UTAR. The aim of this research is to examine on the perception on the implementation of BIM in FM. The result of this research is able to provide some useful information and insights to industry practitioners or policy makers on how to improve the adoption rate of BIM in FM.

Malaysia FM industries should follow the world modernization pace by adopting new technologies to retain their competitive advantage in the business market. Therefore, the relationship of independent variables (perceived ease of use and perceived usefulness) and also the moderating factors (technological factor, economic factor, organizational factor, environmental factor) towards the intention of implantation and actual adoption level have been examined in detail to highlight the main influencing factors towards the adoption of BIM in FM.

This research is able to provide some implications to the readers regarding on the adoption rate of BIM as an advent technological innovation tool in management system, and what are the driving and pulling back factors.

ABSTRACT

BIM is a new popular approach applied in designing and management of a construction building. Its ability to create a virtual model of a physical object and further involve different project stakeholders in the virtual representation to enhance the collaboration and sharing of all critical information before it is being built is in great favour of the construction industry. Its application to FM, however, is still limited. Previous studies had found that the implementation of BIM in FM can bring significant benefits and resulting in lower maintenance and operation costs.

Inspired by this, the study is done to determine on the actual factors which drive the intension to use BIM in FM by applying an integrated TAM (Technology Acceptance Model) and TOE (Technology Organization Environment) framework. Factors such as perceived usefulness and perceived ease of use are under the framework of TAM, combined with external factors of technological, organizational, environmental from TOE, meanwhile economic factor is also included to comprehensively determine the relationship between these variables towards the intension of use of BIM in FM.

A questionnaire survey was conducted with a total of 102 responses collected. Data analysis was done by using PLS-SEM method. The study's findings found that perceived ease of use is having positive impact towards intension to use BIM in FM, environmental factors are also helping to drive intension to use BIM in FM at the same time. Moreover, it was found that the perceived ease of use of BIM is depending on the technological and organizational factors which have positive significant relation to it.

The findings of this study could be a guideline for BIM software developers and policies makers to have an idea on where should the effort be done in order to help in BIM–FM implementation.

CHAPTER 1

INTRODUCTION

1.0 Introduction

An overview of the research topic will be provided in the first chapter, starting from the background information, followed by the problem statement, and research questions will then be listed out, hence coming out with the research objectives in order to address the research questions. The significant of the study will also be clearly explained in this chapter. At the end of the chapter, a chapter layout will be illustrated to let readers familiar about the flow of the report.

1.1 Research Background

BIM is a new and innovative approach in designing the building introduced by Professor Charles M. Eastman since 1970 (Bryde, Broquetas & Volm, 2013; Eadie, Browne, Odeyinka, McKeown & McNiff, 2013). The BIM process is a creation of an advanced 3D model for the proposed project which comprises all structural, architectural, and MEP components. By building a visual representation of how all of these systems interact with one another, project stakeholders can better coordinate with each other during the design stages. BIM was firstly implemented in United States of America (USA) (Ilter & Ergen, 2015), then followed by other countries such as Singapore, Hong Kong, United Kingdom (UK), Australia, Denmark, Norway and Finland (Ilter & Ergen, 2015; Volk, Stengel & Schultmann, 2014).

The implementation of BIM might be new to some developing countries; however, its adoption rate in many developed countries is relatively high. Because of major developments in software and hardware technology during the last decade, the BIM method has been more extensively employed. BIM is a solution method to digitise the representation of a building as a computer-generated model and allowing critical information to be integrated in these models. Currently, BIM is a widely-used software which had created a more in-depth cooperation for project stakeholders like architects, engineers, contractors and project managers, to achieve better integration and coordination, resulting in project cost and time saving, fewer errors and improved design.

When we think about the building's management during post-construction, the tasks of managing the facilities are fall under the facilities managers. BIM is also recommended to be applied by facilities managers in carrying out their managing tasks after the construction and development is completed. The implementation of BIM in FM is vitally important as the major part of the residential building cost fall under the maintenance and operating expenses which contributed one third to one half over the total cost depending on the type of building for instance flat, apartment, condominium, or others. Meanwhile, between 70% and 85% of the building maintenance and operation costs can be influenced during the design stage. This significance amount of building life cycle costs has raised the awareness of practitioners to look into FM so that cost-effective planning or sustainable design of building can be achieved (Che-Ghani, Myeda & Ali, 2016).

A facility's physical and functional attributes can be represented digitally in BIM, providing a trustworthy foundation for decisions throughout the facility's lifecycle (Prihatono & Adi, 2020). The latest idea of constructing a "digital twin" which stands for a virtual model of a physical object is align with the objective of implementing BIM in FM. With the implementation of a fully-integrated BIM model, a safer, more efficient, and more resilient built environment can be achieved.

Facility Management (FM) is defined as "a profession that encompasses multiple disciplines to ensure functionality of the built environment by integrating people, place, processes and technology" according to the International Facility Management Association (IFMA) (Wang, Wang, Wang, Yung & Jun, 2013). Facilities management is a complex process which requires manager to adopted with professional management skills, and at the mean time implementing the suitable hardware and software tools to assist the management process (Smith, 2002). FM which plays an important role in building lifecycle however is always excluded during project phases before BIM is evolving (Dixit, Venkatraj, Ostadalimakhmalbaf, Pariafsai & Lavy, 2019).

The ability of BIM to integrate data from multiple sources into a common interface and display in a virtual model can assist facilities managers in overseeing and visualise the whole building structure and all the components within it. Therefore, achieving better post occupancy building management, maintenance and service. Activity of repair, protect and monitor the building can be done easier with the help of BIM tool.

The Malaysian Public Work and Department (PWD) introduced BIM into the construction industry in the early of 2007, with a publication of their BIM Standard Manual and Guidelines (Sinoh, 2020). PWD is also in charge of forming a BIM committee for BIM training tools and creating a BIM Roadmap (Sinoh, 2020). However, it took a long time to practically implemented BIM in Malaysia (Wan Mohammad, Abdullah, Ismail & Takim, 2018).

Works Minister Datuk Seri Fadillah Yusof announced that BIM had become a mandatory system to be used for any public project with the amount of RM100 million and above starting from 2019 (Yusof & Shah, 2017). Construction Industry Development Board (CIDB) also support the mandatory implementation of BIM for private sector projects by 2020 (Abd Rashid, 2020). Other efforts done by CIDB is the established of the first BIM Steering Committee and the creation of a BIM Portal (Sinoh, 2020). Meanwhile, the Malaysian Construction Research Institute (CREAM) is also offering BIM training and education to the practitioners and the Multimedia Super Corridor (MSC) is providing funds for BIM training and certificating (Sinoh, 2020). Furthermore, the adoption of BIM in the Malaysian public sector would be facilitated and accelerated by the availability of the application systems under E-plan flagship projects like the Sumber-Putra, Selangor Electronic Planning Approval System (SEPAS), and others (Harun, Samad, Mohd Nawi & Haron, 2016).

1.2 Problem Statement

However, the utilisation of BIM for FM is still at infancy. Also, less effort has been done to include FM into the early building design planning and construction process in current construction practice. In most cases, designers are designing the building based on assumptions about numbers of occupancy, usage, and air and water flow rates (Abuimara, Hobson, Gunay, Brien & Kane, 2021). However, these input data are retrieved straightly from secondary data, for instance the Standard Annex and Design codes. Neglecting that these assumptions might be not fix to real life case and might lead to under design or over design. Moreover, if the designers are not familiar and master about the equipment's operational knowledge, the worst case is the whole system is not functioning in a desirable way, and becoming a problem instead.

Also, the implementation of maintenance strategy can only be done later by facilities managers on the as-built buildings, after the buildings were designed and constructed by other parties and handled over to them. However, doing any adjustment during the post-construction period is often ineffective and expensive. The later the corrective action, the more the effort required to alter the outcomes. In a result, the project is often delayed, over budget or the design outcome is not up to users' needs. Based on the reseacher, the inevitable long-term maintenance and operation cost incurred to the building is about 70% and 85% influenced during the design stage (Che-Ghani, 2016). Involvement of facilities management helps to provide better design as facilities manager will take into consideration of all the requirements from internal, external parties and also the big environment. This further prevent undesirable facilities design and also reducing the needs for major renovations and alternations during the operational phase.

Meanwhile, many of the valuable information required for proper facility management are lost or untracked during the handling over process. Also, the traditional building information record is relatively slower, not organized, not systematic and not collective. All these circumstances are leading to inefficient management, higher costs and time-consuming. (Puķite & Geipele, 2017) defined a good management as transparent and reliable operations; regular reporting and participation; and fast reaction to client feedbacks. One of the main tasks at management level is that manager has to be good in overseeing all the things and decision-making. Also, when a vital maintenance and repair works which is threatening the safety and life of the occupants occurs, the managers have to come out with immediate solution.

Another issue is that the facilities managers must familiar with all the technical components of the facilities installed, especially for the complex facilities and equipment. Due to the technicality of vast technologies, it is difficult to successfully manage all the facilities without knowing all the related information about the components. Dealing with huge amount of data is impossible unless there is an efficient and accurate data handling system. A good reporting and documentation system is required for facilities management to manage projects effectively and efficiently throughout the lifecycle.

Another common difficulty faced by the facilities managers is the presentation demonstration and reporting of the issue, measure, system, technology to upper management, building owners or lessee who are likely comes from a non-technical background. A very supportive and persuasive evidence must be presented to them in order to get the finance, otherwise the proposal is not likely to be approved. Meanwhile, non-technical might not understand the data presented without a virtual model display. Therefore, BIM comes in as an assisting tool to integrate data from multiple sources into a common interface and display in a virtual model which is helpful for facility manager to carry out their tasks efficiency. It can benefit in the aspect of operational and managerial, with additional adaptability and flexibility. When integrating FM with BIM, it can be upgraded to a 6D modelling (Pärn, Edwards & Sing, 2017), which helps to simplify the information handover process, improving FM efficiency and achieving better managed facilities (Olapade & Ekemode, 2018) which maximize the benefit of BIM (Underwood & Isikdag, 2011).

Nevertheless, adoption rate of BIM in FM is relatively low, as compared to its adoption rate in design and construction phase use (Bryde et al., 2013; Eadie et al., 2013). Obviously, many of the practitioners are not fully understand the benefits and conveniences brought by BIM to FM. This has gained the interest of researchers to study on the topic of FM-BIM integration.

In addition, many past studies had shown that external factors such as technological, economic, organizational and environmental are the main factors affecting the organization's adoption of technology, However, the individual acceptance is depending on their perception towards the usefulness of the technology and also the ease of use of the technology. Hence, all these factors are relating to the actual adoption rate of the BIM. Thus, by investigating the direct influence of perceived usefulness and perceived ease of use, together with the relationship of external factors, this research is aimed to provide a comprehensive insight on directions to improve the implementation of BIM in FM.

1.3 Research Question(s)

1. Is the perceived ease of use directly influence the intension to use BIM in FM?
2. Is the perceived usefulness directly influence the intension to use BIM in FM?
3. What are the external factors which influence the perceived ease of use, perceived usefulness and intension to use BIM in FM?

1.4 Research Objective(s)

This research will focus on the relationship of perception towards the implementation of BIM in FM. Meanwhile, the external factors which influence the perception will also be covered in the study.

1. To investigate the relationship between perceived ease of use and intension to use BIM in FM.

2. To investigate the relationship between perceived usefulness and intension to use of BIM in FM.

3. To investigate the external factors which affects the perceived ease of use, the perceived usefulness and the intention to implement BIM in FM.

1.5 Significance of the Research

First and foremost, future researchers can benefit from this study by knowing what are the factors that influence the human acceptance of BIM in FM. Detail understanding on social behavior is helpful to narrow down the future scope of study and at the same time drawing focus to the main factors which tends to drive the intension of people to implement it.

It is crucial to understand the concern of public when a new technology is promoted, therefore, another significance of the study is that the outcome can be used a guide by the BIM developers to design or improve the BIM software. The software should be designed to suit the users then only it can be accepted by the public.

In the perspective of the users, this research helps them to identify the aspects which should be considered before the implementation of BIM in FM. After considering of various factors in the proposed frameworks, their own perception towards implementation of BIM in FM can be generated. Biased opinions due to lacking of knowledge can be eliminated.

Last but not least, this research is also targeted to produce an outcome which drive the implementation of BIM in FM and at the meantime hoping to bring the benefits to every stakeholder involved in the built environment. The implementation of BIM in FM is believed to bring a lot of benefits to the facilities managers and the built environment. For instance, BIM as a tool used to create the virtual digital twin, it helps facilities manager to have better overseeing on the whole building, hence improving the productivity and performance in handling their tasks. Traditional management process is usually done based on the 2D drawing which is difficult to achieve a good collaboration between every project stakeholder, especially for very huge project with a lot of parties involved. BIM is therefore important to act as a mutual platform for different stakeholders to share, exchange and retrieve the information which they required. Also, with the implementation of BIM, involvement of FM during the design and pre-construction stage can be achieved. As a result, the built environment is well-designed, organized, comfortable and sustainable. Last but not least, the public as the end-user of the built environment can enjoy a better-quality life.

1.6 Outline of the Research

This research project report is divided into five chapters. The first chapter will be an overview to the research on the topic of 'Perception on The Implementation of BIM in FM'. The research background, problem statement, research question, research objective and significant of the study will be described in this Chapter.

Review on BIM in FM through existing related literatures is summarized in Chapter 2. Thereafter, a theoretical framework is drawn to serve as the theoretical backbone, as well as the hypotheses are developed in this chapter.

Followed by Chapter 3, the methodology used to conduct the research is explained in details.

The results of the research will be presented in table and chart forms in Chapter 4. Explanation to the figures and tables will be provided to assist read in understanding the meaning of the presented data.

Conclusion will be made in the last chapter, Chapter 5. Meanwhile, the suggestion on implication, limitation of the study and recommendation will also be included in Chapter 5.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

This chapter is about the review of previous studies related to FM and BIM. At the beginning of chapter, a detail explanation on FM and implementation of BIM in FM are summarized. Detail information about the advantages, challenges and current status will also be disclosed. Furthermore, an overview of the chosen theoretical framework and its structures will be covered. Set of hypotheses will be developed after reviewing and analysing on the research models. Conclusion of the chapter will also be provided at the end of chapter.

2.1 FM

2.1.1 Overview

Most companies in Asia have knowing the importance of FM in generating maximum returns for the organisation however the roles and responsibilities of FM is yet to standardized. Based on International Facilities Management Association (IFMA), FM is defined profession or service provision which functions to ensure the satisfactory and workability of the Built Environment by integrating the technology, process, place, to people, and environment, meanwhile including a variety of disciplines. The scope included the management of core and shell of a base building, building services, and interior fit-outs which are all referred to the built environment. Each element of the asset must function well over its entire lifecycle, with prolong lifetime, low operations and maintenance expenses, enhancing the quality of the indoor environment, and ensuring the sustainability of the assets.

Different facilities managers are giving out different statements when they are being asked about their roles and responsibilities (Awang, Mohammed, Md. Shalleh, Johari & Khair, 2017); different professions also interpret FM in different ways (Mohd Isa, Nisam Kamaruzzaman, Mohammed, Jaapar & Zaliza Asbollah, 2016). IFMA conducted a survey in 2001, maintenance and operations (91%) is the most rated answer for roles and responsibilites of FM followed by facility planning (88%), planning and management of public (86%), design projects and manage the construction (84%), energy management (75%), environmental health and safety (58%), property management (56%), administrative (52%), and information technology (8%) (Awang et al., 2017).

International facility management ISO standards listed some different areas of FM which are Energy Management (ISO 50001), Asset Management (ISO 55001), Safety Management (ISO 45001) and Security Management (ISO 27001) (Alavi & Matheu, 2019). Specific roles of FM might be related to conservation or renovation of building, cleaning services, security services, parking services, electricity supply, telecommunication supply, fire-fighting system, heating and ventilation system, lift system, landscaping and any facilities in the building (Mohd Isa et al., 2016).

FM is not an easy task as every single facility developed will require good maintenance to ensure it functions efficiently and effectively. The importance of FM can be summarized into achieving sustainable environment and function facilities, promoting business growth, and improving human capital development (Awang et al., 2017).

Nevertheless, the objective of FM is always the same, which is to reduce maintenance costs, maintain the quality of facilities provided in order to maximize organization's profit. FM is also defined earlier as an integration of place, process, technology and people which include the managing of physical, non-physical facilities and also the unexpected business requirements (Mohd Isa et al., 2016).

FM is a discipline that consists of numerous operations, activities, and maintenance services that support the primary functions of a building or facility that is in use therefore it necessitates detailed information about the facilities (Yalcinkaya & Singh, 2014). While many FM information systems are already utilised to manage such data, the diverse graphical and non-graphical information saved in BIM from the pre-operation phase is however not been effectively integrated into existing FM systems facilities (Yalcinkaya & Singh, 2014). With the visualisation, interoperability, and information exchange ability, BIM software has the potential to streamline FM activities. Hence, the implementation of BIM for FM has gained the interest of researches in order to improve the effectiveness of FM.

2.1.2 Advantages

The most notable benefit of effective FM is the reduction of wastage, downtime, maintenance and operation cost, therefore profitability increased. The long-term return of investment is superb as energy, water use, repairs, maintenance, and replacement all these lifetime costs are contributing the major parts of the total cost for each development. On the other hand, profitability can be attained through tenancy extension, retention, and higher rents brought on by increasing of tenant satisfaction.

An efficient FM helps to detect problems faster and easier, and resulting in increased effectiveness, sustainable and long-term profitability. A few more non-monetary advantages are safe, healthy, clean, conducive to business environment and comfortable in terms of temperature and sound.

FM is also in a vital position in order to create a sustainable environment. The performance of FM has a great impact on the occupant behaviours and also the environments. The energy-efficient structures, green technology, complex building environmental systems are also vital in order to satisfy the growing demand for comfort and high-quality lives, at the same time remain sustainable. Meanwhile, FM is also crucial in ensuring the sustainability of business in market for long period (Kamaruzzaman, Myeda, Zawawi & Ramli, 2018). Ultimate advantage is higher building value appreciation, better image, reduced long-term cost, achieving long-term gain (Mohd Isa et al., 2016).

Many will not be knowing that FM is actually playing an important role until a system failure, hazards to the safety and health of the occupants, fall in the value of the property, and increased operating costs happen. Another truth that is commonly disregarded is the fact that buildings have long lifespans and thus need constant upkeep, repair, and retrofitting.

2.1.3 Challenges

In a study of facilities management practices in public buildings in South Africa by Mewomo, Ndlovu & Iyiola in year 2022, the quantitative result revealed that the factors which affect the effectiveness of FM practices can be categorized into organisational factors, followed with errors in structural design and end users' behaviours. In details, the significant factors can be related to the availability of capitals, end-users' knowledge of FM, policy guidance on FM practice, building design and the state of deterioration of building and facilities.

Planning and responding to emergency and disaster was the largest challenge to FM (Mohd Isa et al., 2016). In traditional FM practices, systems such as Computer Maintenance Management System (CMMS) and Computer Aided Facilities Management System (CAFM) are applied by facilities manager in handling of FM tasks. However, such systems are insufficient to handle huge amount of digital information during the handover stage. The building-related information is always unorganized and fragmented, hence making it difficult for facilities managers to retrieve and access during the building's maintenance and operation phase (Azzran, 2018).

2.1.4 Current Status

FM practices in Malaysia is not likely same with FM practices in US and UK (Mohd Isa et al., 2016). In Malaysia, people always link the FM with building maintenance (Awang et al., 2017). FM is found to still in infant stage in Malaysia. Fortunately, government organisations like JKR have adopted and are practicing FM lately. In conjunction with that, the trend and awareness of sustainable FM is trending upward and becoming more popular (Zaliza Asbollah, Mohd Isa & Nizam Kamaruzzaman, 2016).

FM is of critical to the efficient operation of a facility in the post-occupancy period; hence, there is an urgent need for FM practises to embrace the principles of digitization and sustainability. With the implementation of BIM, the FM and building energy modelling procedures can be digitalized, allowing us to save money while conserving the environment (Khan & Ali, 2022).

2.2 Implementation of BIM in FM

2.2.1 Overview

BIM plays an important role in automation of construction and corresponding management of the building systems with proven functions such as effective visualization, informatization, standardization, and collaboration of different parties during the entire lifecycle (GhaffarianHoseini, Zhang, Nwadigo, GhaffarianHoseini, Naismith, Tookey & Raahemifar, 2017). There are many different steps in the delivery of a building construction project, through design, construction, contracting, and maintenance. The process is long, complex and involve many different professional input from different teams. The information tracking, presenting, sharing, collaborating, and updating is therefore vital through the whole project cycle. As a result, BIM is the most popular and effective information exchange tool used between every player during the project cycle.

To be sustainable, a business must be moving align with the development of technology, innovative and periodically improvement is necessary (Kamaruzzaman et al., 2018). BIM employs cutting-edge digital technology to create a computable virtual representation of the physical properties and functional characteristics of a facility, as well as the relating life-cycle information, and is intended to serve as a system of record for the facility manager to use and maintain throughout the facility's life-cycle. (Edirisingheet al., 2016). BIM will only be successful if stakeholders collaborate and having a common vision and mission. The society can enjoy the benefits brought by

BIM, for instance more accessible infrastructure and housing, safer and more reliable planning process, a more sustainable and resilience environment, and high-quality service delivery to end users (Sinenko, Hanitsch, Aliev & Volovik, 2020).

2.2.2 Advantages

The benefits of BIM result in enhanced effectiveness in project delivery starting from preliminary design stage, to construction stage and even after post-construction maintenance stage. BIM is an effective method to enable the interchange of construction information because of these anticipated advantages.

BIM serves its purpose throughout all phases of the construction project by providing advantages in terms of better design quality, ease of implementation, information sharing capability, reduction of construction costs and design errors, faster work and shorter construction times, improving energy efficiency, supporting construction and project management, and assisting owners to operate their buildings more effectively throughout their lifespan (Doumbouya, Gao & Guan, 2016).

Some of other benefits acquired by implementing BIM in FM are lower operation cost, faster decision making, better documentation system, higher collaborative and work flexibility, easier information updating and clash detection (Aziz, Nawawi & Ariff, 2016).

The top four main clusters of the project stakeholders benefited from the adoption of BIM in construction projects: is the architect and structural design with 10 proven benefits, followed by FM with another 8 benefits, contractors with 6 benefits, and lasty the owners with the gain of 6 benefits (Toan et al., 2022). Digitalizing and storing asset information and creating a cost database would also be helpful to quantity surveyors with the implementation of BIM in FM (Stride, Hon, Liu & Xia, 2020). While the top advantages for facility management units were convenient for organising project data and simple planning and resource mobilisation.

BIM is a helpful tool to provide useful engineering information for assessment of greenhouse gas emission during the whole project life cycle which included materialization stage, the operation and maintenance stage, and the demolition stage (Cheng, Li, Tam, Yang & Chen, 2020). It is also highlighted that BIM helps in reducing building energy consumptions and increasing sustainability performances (GhaffarianHoseini et al., 2017). There is also a case study by Najjar, Figueiredo, Evangelista, Hammad, Tam & Haddad (2022) which implemented BIM in estimating the operating energy performance and evaluating endpoint impacts of building materials at an early designing stage of a multi-story office building. The result showed that steel construction is more environmentally friend as compared to concrete construction for the case study. The deployment of BIM in the sustainable affordable housing construction project in Malaysia is align with the Public Work Department Strategic Plan 2021–2025, and help it to attain 80% of entire implementation by 2025. Additionally, this would lessen the impact on the environment and promote UN Sustainable Development Goal 11 (SDG 11) for the 2030 Agenda (UN) (Rahim, Ismail, Habib & Chofreh, 2022).

The advent of BIM and its integration with other advances in FM, the Internet of Things (IoT), Big Data, and others has made it possible to convert these types of buildings into more efficient smart buildings using BIM-FM techniques and custom sensors without making sizable investments. Moreover, the incorporation of BIM with a Building Management System (BMS) tends to automate the whole process, boost the efficiency with less manual input required.

In a study of Pavón, Alberti, Álvarez & Carrasco (2021), the result has demonstrated that a building may become a Smart Building by using a three-dimensional model as its management hub and connecting to other apps, databases, and facility management technologies. Additionally, the system may be managed online, bringing information to both the management team and the user. All innovations were self-created to meet the unique requirements of the building.

Concept of multiple dimensional building information modeling (nD BIM) summarizes the benefits of BIM in different phases of construction and promotes the integration of project deliver. There are 2D modeling which referring to conventional drawings, 3D modeling which referring to entities with z-perspective, 4D modeling which included scheduling after adding time dimension, 5D modeling which move forward to estimation incorporating financial planning, 6D modeling is towards sustainability by attaching environmental information, and 7D modeling is for facility management where all relevant building component information must be accounted (GhaffarianHoseini et al., 2017). Referring to the Table below, a 7D facilities management only take place during construction, operation and maintenance stage. In fact, facilities management is recommended in many researcher papers to be involved also in the planning and design stage. With implementation of a 7D BIM, the incorporation of facilities management during early design and planning stage is possible as a virtual model is enhancing the multiple stakeholder collaboration.

Table 2.1: Applications of Multiple Dimensional BIM and Its Involvement During Project Stages (GhaffarianHoseini et al., 2017)

Dimension	Typical Applications	Involvement during project stages
2D (Drawing)	1. Project design and study 2. Generating layouts and sections	Planning, Design, Construction
3D (Entities)	1. Coordination between multi-disciplinaries 2. Animation and presentation 3. Digital manufacturing	Planning, Design, Construction, Operation, Maintenance
4D (Scheduling)	1. Construction process planning 2. Quality management	Construction

5D (Estimation)	1. Budgeting 2.Cash flow analysis	Planning, Design, Construction, Operation
6D (Sustainability)	1. As-built operations 2. Energy consumption monitoring	Planning, Design, Construction, Operation, Maintenance
7D (Facilities Management)	1. Bulding lifecycle performance assessment 2. Asset lifecycle management	Construction, Operation, Maintenance

In a review of benefits of BIM in the operation and maintenance phase for green buildings by Hoang, Vu, Le and Nguyen (2020), advantages of BIM in building repair and maintenance, building energy management, space management, asset management, building security, safety and emergency management, renovation and retrofitting are disclosed. The main contribution of BIM is allowing all stakeholders to input, share, and utilize the physical and functional building and facilities relevant information in a digital presentation to design, construct and operate through the whole building lifecycle.

There is another function of BIM which is the ability of simulation of energy consumption conditions in the model. The input of energy-related information for instance the location, climatic condition, sun path, thermal radiation, weather, building geometry, properties of building material and the percentage of utilization can be manually or automatically done by sensors, laser scanning, photogrammetry, and passive RFID tags , to simulate the natural light, temperature, heat radiation, air flow and ventilation, humidity, and terrain of the interior and surrounding environment, allowing for projection of the energy consumption based on this data (Cao & Aziz, 2022).With integration of Internet of Things (IoT), the system can become even intelligent in controling and optimising energy use based on the condition of surrounding environment and in conjunction with machine-learned data trend (Cao & Aziz, 2022).

Green buildings are having extra requirements such as greater comfort, energy efficiency, low pollution, low toxis emmissions, and environmental friendly (Cao & Aziz, 2022). The difficulty of FM in green building will be higher and require the assist of BIM tools to handle tasks more effectively.

Security data monitoring, managing and storing can be done by BIM in order to enhance the security of building (Cao & Aziz, 2022). Another capability of BIM is the demonstration in virtual of planned location and types of security device to be installed (Cao & Aziz, 2022). End up, the cost estimations and demonstration of different planning options can be done easily with the assist of BIM for facilities manager to compare the cost-benefits and come out with better decision.

Similarly, different options of retrofit and renovation can be modeled in BIM to carry out an accurate cost-benefit analysis. The performance and consequence of different renovation and retrofitting scenarios can be simulated in BIM (Cao & Aziz, 2022). The waste produced can be minimized, renewable and recycleable building material can be identified, and errors and delays of the site works can also be reduced (Cao & Aziz, 2022).

Through BIM, space-related information such as space area and utilization status can be displayed in a 3D model and further reflect to the area occupied per person, average expenditure per unit area. Hence detailed analysis of cost can be done and space efficient can be optimized (Cao & Aziz, 2022). On the other hand, forecasted space requirements for moving, maintenance access and placement of furnitures and facilities, indoor path navigation can be done easily in BIM which helps facilties managers to do better arrangement in space utilization and reduces the manual workload (Cao & Aziz, 2022).

In asset management, BIM assist facility manager to overcome the issue of insufficient interoperability and poor building information recording. BIM act as a compiling platform for enormous building related data such as detail information about mechanical, electrical, structural, infra, space, standards for access and circulation, regulations and specifications for buildings. Other information needed by facilities managers such as systems and equipment component list, database attributes, inspection report, maintenance and replacement cost report, installation manuals, preventive maintenance schedule, failure test report can also be incorporated into a BIM file (Cao & Aziz, 2022). Hence making the building information handover process easy and complete. The results of case studies and expert interviews in Perth, Western Australia showed that project handover guidelines were frequently disregarded in building projects in Western Australia. Most project stakeholders also did not give the handover phase the same priority as the design and construction phases, which resulted in information and knowledge gaps between the project construction and post-occupancy phases (Tan, Zaman & Sutrisna, 2018).

In overall, BIM can bring benefits to FM in terms of improved collaboration, interoperability and workforce engagement, accurate information and easy retrieval, model automating update, proactive maintenance, increased employee productivity and efficiency, reduce response time in operations, higher level of emergency preparedness, better evaluation of energy efficiency, reduced operational cost, clear presentation of FM requirement for design and construction, and better customer service (Hoang et al., 2020).

2.2.3 Challenges

The results of study by Wijekoon, Manewa & Ross (2020) support the importance of information sharing between the construction and FM phases of a project for both the efficient and effective maintenance of a facility and optimization of the design, however, the ideal amount of data that should be incorporated in a BIM model for FM purposes is not yet clearly defined. One of the difficulties in enabling BIM-FM practises is the definition of the data requirements and determination of who should deliver the data and when during the project lifecycle. Even if the data requirements are set early on, it is difficult to adhere to these criteria due to the dynamic and fragmented nature of a construction project (Yalcinkaya & Singh, 2014).

Interoperability and automatic electronic data transfer are critical for maximising the implementation of BIM in FM (Yalcinkaya & Singh, 2014). Adoption on BIM in Operation and Maintenance is hindered by challenges such as interoperability, understanding of the underlying principles for BIM implementation in Operation and Maintenance, and return on investment (Gao & Pishdad-Bozorgi, 2019). Similarly in a study by Edirisinghe, Kalutara and London (2016), challenges such as cost and resources, complex nature of organisation and priorities, lack of motivation from industry and requirements set by government, incompatibility with FM data entry were found to outweigh the benefits causing low implementation of BIM in FM.

BIM implementation process is disrupted by difficulties to interoperate multiple software applications and versions (Dixit et al., 2019). Challenge in BIM implementation is how to integrate the BIM models with existing FM information systems (Miettinen, Kerosuo, Metsälä & Paavola, 2018). Pishdad-Bozorgi, Gao, Eastman & Self (2018) also stated that data transferable between BIM tools and facilities management systems is of major concern.

Followed with another concern which is the process of collecting information input to BIM throughout each of the project development phases, therefore FM-enabled BIM constitutes must be defined clearly in order to boost the implementation of BIM in FM. Also, different FM practitioners with different FM tasks require different information, the job tasks must be clearly identified at the preliminary stage. At the same time, the additional value BIM provides in relation to the existing information system must be justified (Miettinen et al., 2018).

The difficulty of identifying and formalising the information needed to support FM duties, particularly for existing buildings, poses a significant obstacle to BIM for FMs (Cavka, Staub-French & Poirier, 2017). The study of Alavi and Matheu, in 2019 shows that there is a significant quantity of information in BIM that is not required for carrying out FM tasks, and this results in a heavy BIM model which is hard for model navigation and causing trouble to computer memory. The elements that need additional properties typically belong to the "Services" categories, such as fire systems and mechanical, electrical, and plumbing (MEP) systems; however, asset management and space management mainly require detail information on "Equipment and Furnishing" (Alavi & Matheu, 2019).

According to an interview data conducted in Singapore, the owner and facility managers are fairly aware of and eager to embrace BIM in FM. Five essential components, for instance, the people, process, technology, policy, and BIM manager are identified as potential barriers which obstructing the adoption of BIM in FM (Shen, Edirisinghe & Goh, 2016). The findings of another research conducted on building experts in Nigeria highlighted that the most key obstacles to BIM deployment that should be avoided are cost and standards, process and economic, technology and business, and training and people (Olanrewaju, Kineber, Chileshe & Edwards, 2022).

In a nutshell, significant challenges are the need for improved data integration and interoperability, increased knowledge management, improved measurement of performance, and the training and competence development for facilities managers must also be improved in order to handle the variety of services covered under FM with the use of BIM (Pärn et al., 2017). Mentality, attitude, and resistance of people are the key elements, followed by the relative advantages, compatibility of software, management, training and education, company management support and encouragement, training and education provided by profession bodies, policy, and external pressure are also influencing on the adoption of BIM in construction organisations (Wan Mohammad et al., 2018).

2.2.4 Current Status

Implementing BIM in FM has become popular and supportive for some countries, for instance the Cooperative Research Centre for Construction Innovation in Australia, which had out-lay the National Guideline for Digital Modeling (2009), and the NATSPEC National BIM Guide (2022) which included BIM in FM. Another example of compulsory implementation is in the UK, with the Digital Built Britain Level 3 Building Information Modeling Strategic Plan published by HM Government (2015), in order to promote the interconnected digital design, and further including the operation of assets, and extending BIM application into the whole lifecycle. These policies have encouraged the implementation of BIM in FM in the whole industry.

Meanwhile in some other countries, there is only a mandate to implement BIM during the design and construction phase, for instance Building Construction Authority (BCA) of Singapore has announced the second roadmap of promoting BIM during October 2015 (Das, Leong, Leong, Ng & Ng, 2015), Also, The Department of Planning, Transport, and Infrastructure (DPTI) has created BIM guidelines for government agencies, consultants, and contractors, while the New South Wales Health Department also mandating BIM implementations on all projects worth more than $30 million (Sinenko et al., 2020).

The research of Stromnes (2022) showed that BIM was practically adopted by all Norwegian organisations in different degree depending on the industry's dominant culture which is the main influence factor on the adoption and application of BIM. The SMEs in the industry make up all laggards based on time of adoption, despite not all SMEs are laggards.

Despite there are a lot of proven benefits, the awareness and utilisation of BIM in FM in developing country for instance the Nigeria is still low (Olapade & Ekemode, 2018). Similarly, the adoption of BIM in FM in Vietnam is almost not available despite many of the BIM experts are aware of the benefits brought by BIM (Hoang et al., 2020). The implantation rate of BIM in FM in Canada is also found to be low (Cavka et al., 2017). The adoption of BIM is mainly depended on the requirements from national policies (Qin, Shi, Lyu & Mo, 2020). The research of BIM in Operation and Maintenance is also still in its early stage with major study focus is on energy management (Gao & Pishdad-Bozorgi, 2019).

A survey in United States of America (USA) found that the response from companies which implement or require BIM is positive as BIM improves the project performance, however for companies which do not implement or require BIM think that the biggest barrier of implementation is the high cost. The stakeholder with high usage of BIM is the Project Managers. Representatives from the owner side, facilities managers, project engineers, workers and inspectors however are the stakeholders with the lowest level of usage of BIM. Also, it is found that the implementation of BIM in Commissioning, Operation and Maintenance, and Decommissioning phases is lower as compared to its implementation in Design, Pre-Construction Planning, Construction and Planning phases (Nassereddine, Hatoum & Hanna, 2022).

Despite the adoption of BIM oriented integrated design is supported by Malaysian government, however, other actions are still required to tackle with the low BIM adoption level among SME Malaysia (Arif, Hasmori, Deraman, Yasin & Mohd Yassin, 2021). In a survey done by Othman, Al-Ashmori, Rahmawati, Mugahed Amran & Al-Bared (2020), only 13% of respondents from the public and private sectors, use BIM in their organisations, which is a signal that Malaysia is still lagging behind in the deployment of BIM. The reasons for the slow implementation were noted to be a lack of awareness, expenses, slow adaptation, the absence of a clear guideline to assist businesses and policy-makers toward BIM implementation transformation, and the fact that BIM implementation was not enforced. In terms BIM adoption by Malaysia consultants and contractors, the findings of study by Imoudu (2016) showed that poor collaboration is the main factor leading to significant reduction in the rate of implementation.

Through a study by Memon, Rahman, Memon, Iffah & Azman (2014), the status of implementation of BIM in Malaysian construction industry is found to be very low, the barriers are for instance lack of expertise in operating the BIM, unawareness of the technology and absent of parametric library. The biggest problem facing by quantity surveyors in FM was a lack of precise and full data, some other obstacles included maintaining of model data, expense, industry reluctance to change, and contractors' lack of model adoption (Stride et al., 2020).

Malaysian BIM is also lagging behind other industrialised nations like the United Kingdom and Lithuania in terms of academic literature taught and in real life practice, therefore fully stand-alone BIM module in Malaysian higher education institutions is vital, which in turn hinders the development of high-quality BIM knowledge that masters in methodology and 3D modelling skills (Sima Yusoff, Brahim & Mat Yusoff, 2021). With the existence of both physical and soft infrastructures in Malaysia, the government and its agencies must play key roles in encouraging BIM technology to shape Malaysia to be as competitive as other developed nations (Harun et al., 2016).

2.3 Theoretical and Conceptual Framework

There are many available theoretical models or frameworks which are proposed by researchers to identify the influencing factors towards the users' acceptance behaviour. Technology Acceptance Model (TAM) and Technology-Organization-Environment (TOE) frameworks are among the popular which received considerable attention (Gholami, Abdekhoda & Gavgani, 2018; Bryan & Zuva, 2021). Technology Readiness Index (TRI), Innovation Diffusion Theory (IDT), Theory of Planned Behavior (TBP), are also the example frameworks applied as framework of research studies. This multidimensional character of BIM may make it challenging to develop a comprehensive BIM adoption model (Ahmed & Suliman, 2020). Also, since the level of adoption is varying for different countries, therefore there is currently no an international standardized BIM adoption model (Ahmed & Suliman, 2020).

2.3.1 TAM

One of the basic theoretical models used to investigate the individual acceptance behavior on the information is Technology Acceptance Model (TAM). TAM is developed by Davis in year 1989 and has sufficient empirical support proven to act as a determinant in studying of user acceptance and usage behavior of information technology. TAM is suitable in identifying influencing variables of implementing computing, IT services, and software (Cho, Cheon, Jun & Lee, 2022). The evolution of the TAM model come from the question of what cause people to either reject or accept the IT (Houache, Abd Rahim & Shah, n.d.). Subsequently, the question is derived to will people use the application or not when they think that the application is going to help them in better handling of their job. Furthermore, there is another concern where the potential users might think that the application system is hard and therefore giving up in using it, despite they believe that the application is useful or wise versa (Houache et al., n.d.).

Hence, according to Davis, there are two influencing variables, namely the perceived usefulness and the perceived ease of use which formed the TAM model. In details, the behaviour of adopting information system is a conscious decision-making process which the behaviour is depending on the attitude, where the attitude is determined by two belief factors, the perceived usefulness and perceived ease-of-use. There is a study focusing on BIM technology acceptance among construction industry players in Indonesia conducted with a TAM framework by Prihatono & Adi (2020), found that perceived usefulness is having positive relationship towards BIM technology acceptance.

(Houache et al., n.d.) the perceived usefulness and perceived ease-of-use can only be verified after the implementation of technology, therefore the framework is not suitable to be implemented to study on developing country where the technology is yet implemented. Also, users' perception might be insufficient to cover all aspects related to the actual adoption, other additional factors must be taken into account (Lai & Lee, 2020).

2.3.2 TOE

The technological, organizational and environmental factors are proposed by Tornatzky, Fleischer & Chakrabarti (1990) as a TOE framework. The main principle the TOE framework is that these three factors are influencing the implementation of innovative technologies in organizations. The TOE framework is useful to study on the adoption of the technology in the perspective of organization. The technological factor represents the technologies available to an organisation. The organisation factor defines the features of the organisation, whereas the environment factor defines the business field, which includes industry, rivals, rules, and relationships with the government (Bryan & Zuva, 2021). There are substantial applications of TOE framework in the research to study external factors of BIM technology acceptance (Zhao, Sun, Zhou, Cui & Liu, 2022).

Depending on the situation, the models of TAM and TOE can be applied alone or as a combination (Bryan & Zuva, 2021). An example of integration of TAM-TOE model has been applied by Zhao et al. (2022) to conduct a research study on the acceptance level of BIM technology in China.

2.3.3 TRI

Technology Readiness Index (TRI) consists of a total of 4 variables: optimism and innovativeness which as action enable variables; discomfort and insecurity which act as action inhibit variables. In a TAM and TRI combined model study of adoption of BIM, the result shows that optimism and innovativeness from TRI, with perceived ease of use and perceived usefulness from TAM, and attitudes towards usage are having significant positive relation towards adoption of BIM. While the influence of optimism, discomfort and insecurity are insignificant (Lai & Lee, 2020).

2.3.4 IDT

The Innovation Diffusion Theory (IDT) is another frequently employed BIM adoption model. IDT was developed by Roger in 1962 to explain why, how, and how quickly innovative concepts and technology accepted in a social system (Rogers, 2003). IDT outlines the phases of a company's adoption of technology or innovation, therefore this model only investigating on the technology aspects of BIM. The model depicts the diffusion of innovation as well as the framework of customer reaction determinants to an innovation. Using IDT theory, Panuwatwanich and Peansupap (2013) looked at the elements which influence the spread and adoption of BIM and found that factors which have significantly impacts are relative advantage, compatibility, observability, and complexity.

An integration of TAM-IDT is applied by Xu, Feng & Li (2014) and Kim, Park & Chin (2015) in investigating BIM adoption. There is another research done with an

IDP-TAM model in studying the acceptable of BIM-FM which included six core elements in the model such as awareness of BIM, compatibility with the Computer Aided Facilities Management (CAFM) system, observability, trialability, perceived usefulness, and perceived ease of use (Azzran, Tah & Abanda, 2018).

2.3.5 TBP

Theory of Planned Behavior (TPB) has been extensively used to examine the innovation adoption behaviour in multiple areas and is suitable to serve as a basic theoretical framework when combined with other external impacting elements. According to this theory, the desire to engage in an action is influenced by three primary factors: attitude, subjective norm, and perceived behavioural control. However, little study has been done to characterise the crucial aspects of BIM adoption by implementing TPB (Wu, Jiang, Li, Luo & Li, 2021).

2.3.6 Proposed Conceptual Framework

Despite a lot of models are available, there is an issue that those frameworks only examined a small portion of BIM without taking into account its multidimensional character (Ahmed & Suliman, 2020). Previous researches have shown that different construction types, market procedures, project nature, and project complexity tend to lead to different degree of BIM implementation, therefore, it is hard to develop a suitable and comprehensive BIM adoption framework which is suitable for every country (Belay, Goedert, Woldesenbet & Rokooei, 2021). After reviewing of articles about existing frameworks and journals relating to BIM in FM, a TAM – TOE is proposed to be applied in this research study. TAM, as a model to study for technology acceptance at individual level will continue act as the primary framework and supported by TOE which incorporated technology acceptance at organizational level.

Each study can only focus on the factors which are crucial to the research problem as there are too many affecting factors which are difficult to be tested all in one research at the same time (Houache et al., n.d.). The selection of external variables should be depending on the characteristics of BIM application instead of just following the predefined variables of models (Qin et al., 2020). After certain reviewing, an additional factor of economic is included to the research framework of this study. Wang, Liu & Wang (2016) had also combined a TOE framework with risk and cost element in his study of BIM adoption in enterprises.

Similar to the study of Qin et al. (2020), which had applied TAM as a basic model, and combine it with external variables, for instance the technological factor, organizational factor, environmental factor and economic factors in her study of BIM adoption. As only organizations can make decision on the adoption of BIM in FM therefore influencing factors from the view point of organizations should be accounted. Economic factor which suggested by Songer, Young & Davis (2001), is incorporated as investment cost might increase the risk and influence on an organizations' decisions. The acceptability of BIM technology can differ depending on the size of the organisation. Government requirements are cited as a motivator for major businesses to use BIM technology, however the high cost of BIM is a drawback for smaller businesses (Seed, 2015).

In the proposed framework of this research, economic and environmental are classified as factors relating to perceived usefulness as the economic is referring to 'the generated cost benefits', and environmental is referring to 'competitive advantage within the environment'. However, the relationship of economic factor towards the intension of use is also tested after referring to the model proposed by Qin et al. (2020).

The construction of relationship of both technological and organizational factors towards the perceived usefulness and perceived are illustrated as shown below as this construct had been proved by many other researchers in their journals. For instance, in a study of ICT adoption (Tripopsakul, 2018), technological and organizational factors are having a significant positive impact to the adoption while the perceived usefulness, and perceived ease of use are acting as the mediating variables.

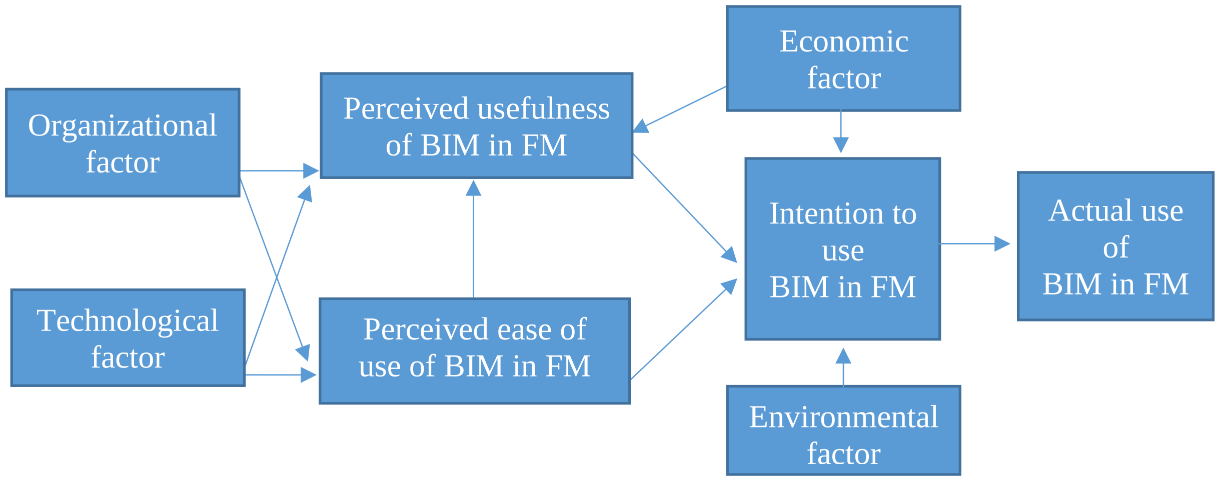

Figure 2.1: Proposed Conceptual Framework

2.4 Hypotheses Development

A diverse of hypotheses can be developed based on the integrated TAM - TOE model as shown above in order to investigate what are the crucial influencing factors. For instance, the relation of economic, environmental, organizational and technological factors toward the perceived usefulness, perceived ease of use, and lastly to intension of implementation of BIM in FM are addressed in this study.

To identify all pertinent indicators to measure the variables, a thorough literature review is conducted. The results of study by Toan, Tam, Diep & Anh (2022) showed that perceived usefulness, perceived benefits of BIM for organization, experience and skills, technology quality, and speed of BIM tools are the most important variables influencing BIM adoption in building project execution. According to the interview results, organization's culture, strategy, management, leadership, perception, awareness, training and learning, knowledge capability, skill and attitude, client demand, financial, BIM complexity, trialability, accessibility, functionality, technology quality, procurement method, are the factors affecting the integration of BIM-FM (Yusnida, Emma & Maimunah, 2022).

The survey of Arif et al. (2021) shows that cost of BIM implementation, and unwillingness in adopting BIM from management level are the top challenges, and followed by lacking of BIM guidelines, standards, and protocols. Also, the implementation of BIM is fragmented by different parties instead of a complete BIM project management. Demonstration of process of the entire system while showing its improvement to effectiveness of the entire work environment is also encouraging factor in boosting the adoption of BIM in FM. Collaboration among parties during project lifecycle are vital to support the BIM implementation, especially when the majority in construction industry does not understand FM, leading to issue in interoperability and data exchange (Naghshbandi, 2016).

2.4.1 Perceived Ease of Use

In terms of perceived ease of use, it can be defined as when people believe that it would be easy to implement the BIM in FM, this would drive their intension to implement it. In many research studies, perceived ease of use is also having a direct influence to perceived usefulness.

H1: There is a positive relationship between perceived ease of use toward intension to use BIM in FM.

H2: There is a positive relationship between perceived ease of use toward perceived usefulness of BIM in FM.

2.4.2 Perceived Usefulness

Perceived usefulness is the main determinant factor of the intension of adopting a new technology in TAM framework. As for this study, it can be simply defined as when the users believe that BIM would improve the FM performance, they would have the intension to adopt it.

H3: There is a positive relationship between perceived usefulness toward intension to use BIM in FM.

2.4.3 External Factors

2.4.3.1 Environmental

The environmental factor is referring to the business environment, with elements beyond the control of the organisation, such as competitors, industry, society, customers, and technology service providers (Tripopsakul, 2018). Previous research has revealed that government support in terms of government BIM policy is essential towards the development and deployment of BIM software (Dong & Martin, 2017). Result of the study by Qin et al. (2020) shows that the requirements from national policies which under environmental factor is coherent to intension of use and is the most significant driving variable of BIM adoption. The positive influence of government BIM policy towards the perceived usefulness is also confirmed in the study by Zhao et al. (2022). On the other hand, the UK government was found to have done a great job in promoting the implementation of BIM (Eadie et al., 2013), and China government has recently declared plans in doing so (MOHURD, 2016). The most effective way to expedite the implementation of a complex technology systems is by having strong government driving force (Dong & Martin, 2017).

H4: There is a direct relationship between environmental factor and intension to use BIM in FM.

2.4.3.2 Economic

A critical factor or barrier that has a direct impact on intention to use is perceived cost burden, it was demonstrated that a high financial burden might still pose a negative effect on intention to use, even if the perceived value in terms of usefulness or ease of use are high (Cho et al., 2022). In a research study of adoption of BIM (Qin et al., 2020), the economic factor is added as an external factors to TAM-TOE which had taken into account of cost of implementation of BIM and also its return on investment. Top management in businesses should be completely aware of the economic benefits given by BIM technology, which encourages managers to aggressively embrace BIM technology (Zhao, 2022). Therefore, in this study, economic is included to study its relationship between intension and perceived usefulness.

H5: There is a direct relationship between economic factor and intension to use BIM in FM.

H6: There is a direct relationship between economic factor and perceived usefulness of BIM in FM.

2.4.3.3 Technological

Good technological performance is one of the main factor affecting the ease of use and also the usefulness of the particular technology. The term "technological context" refers to both internal and external technologies that the organisation is now utilising as well as those that are already on the market but have not yet been adopted by the business (Qin et al., 2020). BIM technology characteristics have been shown to be the most critical element influencing BIM technology acceptability, especially the complexity and interoperability of the software which are depicted as the key concerns where BIM software software developers should address (Zhao et al., 2022). In a study of social media adoption with TAM-TOE framework, it has been discovered that the relative advantage, complexity, compatibility, trialability, and observability are all important technological aspects in affecting the adoption of social media (Tripopsakul, 2018). Trialability, in other words, is the extent to which innovation can be tested on a limited basis. Besides, observability is the ability to measure and understand the internal states what's happening in a system by examining its outputs.

Qin et al. (2020) had divided technical factors into three main categories which are localization, standardization and compatibility. Localization is a concern when introducing a new technology to a region or country, the technology should meet the demands and preferences of local users, including the software operating environment and also local project practices and management process (Qin et al.,2020). Standardization is referring to the same milestones, goals, data transferring and deliverables process, content and format in order for better collaboration; compatibility is focusing on the software' integration and compatibility with one another (Qin et al., 2020).

Technological quality, and speed of BIM tools are the focus point (Toan et al., 2022). With reference to the research study of Van Tam et al. (2021), some other factors categorized under technological are for instance the feasibility of BIM, IT support, trialability, accessibility, BIM complexity, functionality, technology quality, result demonstrability, speed of BIM software and procurement methods.

H7: There is a direct relationship between technological factor and perceived usefulness of BIM in FM.

H8: There is a direct relationship between technological factor and perceived ease of use of BIM in FM.

2.4.3.4 Organizational

Technological diffusion process is influenced by a firm's formal and informal structures, procedures, attitudes, and cultural characteristics (Tornatzky et al., 1990). Technology diffusion needs adequate organisational competency and support in providing sufficient resources, which then ease the diffusion. For instance, working mode and flow, management style, support from senior management, organization expertise level that particular technology are the organizational factors which should be taken into consideration (Qin et al., 2020).

H9: There is a direct relationship between organizational factor and perceived usefulness of BIM in FM.

H10: There is a direct relationship between organizational factor and perceived ease of use of BIM in FM.

2.5 Conclusion

Chapter 2 provides a detail explanation on the overview, advantages, challenges and current status of FM and also implementation of BIM in FM. Besides, systematic review of theoretical frameworks together with the variables is done and came out with the proposed framework for this research. Based on the independent variables such as economic, environmental, organizational, technological, perceived usefulness, perceived ease of use and the dependent variable which is the intension to use, a total of 10 hypotheses are derived and explained in this chapter.

CHAPTER 3

METHODOLOGY

3.0 Introduction

The research methodology employed for this study is described in this chapter. First and foremost, an overview of the research process is shown and followed with detail discussions on each process. For instance, process in stage 1 the identification of research issue problem statement, and stage 2 literature review based on the selected topic will be explained. The main focus will be the stage 3, the research design process. The research instrument which consists of the questionnaire design, construct measurements and sampling method are presented in details. Furthermore, data collection method in stage 4 and data analysis method in stage 5 are also highlighted in this chapter. This chapter will also be concluded with a brief summary at the end of the chapter.

3.1 Research Process

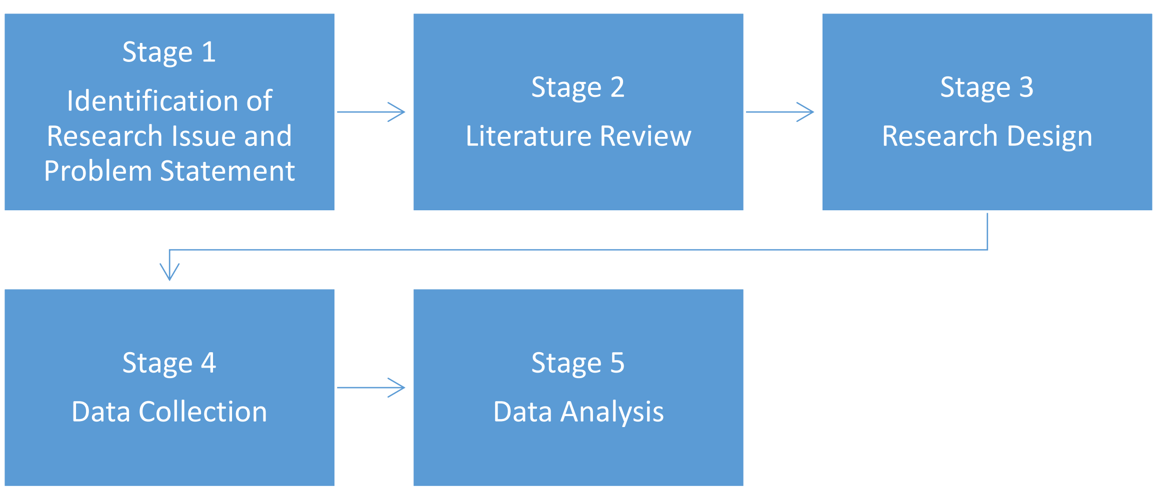

Figure 3.1: Flow Chart of Research Progress

3.2 Identification of Research Issue and Problem Statement

In the most initial stage, through study on latest relating news and with consideration of own interest of study area, a research topic is chosen and followed with lot of study on the exploratory research papers to identify the research issue and then proceed to the problem statement formulation.

3.3 Literature Review

A detail literature review is done and leading to the forming of the hypothesis and proposing of the theoretical framework of this study. The literature review mainly focuses on the current status of BIM adoption in FM, the barriers, challenges and advantages of its implementation. Meanwhile, frameworks applied by other business and social science researchers to study the technology adoption are reviewed. Hence, an appropriate research model is developed to study the perception on the implementation of BIM in FM in this study.

3.4 Research Design

Research is targeted to be conducted in November 2022 to collect information regarding the topic of perception towards the implementation of BIM in FM within the time period of a month. This research will be conducted in Malaysia.

3.4.1 Research Type

There are two different types of research namely qualitative and quantitative. Qualitative research is referring to research process of collecting and analysing of non-numerical data for instance the review in the form of text, video, or audio in order to understand better about the ideas, opinions, experiences or problems and further generate direction for further research. However, another type of research, the quantitative research is totally opposite of the qualitative research. Quantitative research is representing process which deliberately gathering and examining numerical data in order to describe, forecast, or regulate key factors. Testing causal links between variables, making predictions, and extrapolating findings to larger populations are the objectives of quantitative research.

This research is designed as a quantitative study since the characteristics of a quantitative study is more adhere with the purpose of study in order to understand the perception of Malaysian towards the implementation of BIM in FM by collecting of numerical data for data analysis and drawing conclusions based on the results.

3.4.2 Research Instruments

Research instruments are referring to the tools which help researchers to collect necessary information, measure and analysis the data, for instance the questionnaires, interviews, observations, analysis software and so on.

Questionnaires would be the main research instrument paired up with data analysis software being applied in this research to study the relationship between variables. The reason behind the chosen instruments is because a questionnaire survey can easily and systematically compile people's ideas and opinions on a certain topic in a well-organized way. It is highly effective and efficient to analyze, generate result, and draw conclusion based on the compiled data imported to the SPSS software.

A total of 68 questions are prepared to survey for feedbacks from practitioners and further analyse on the effects between the variables. The questionnaire is divided into 9 sections. Section 1 is asking for the personal demographic and Section 2 is related to BIM adoption in company. Questions about perceived ease of use of BIM in FM are under section 3; however, questions about perceived usefulness of BIM in FM are under section 4. Followed with Section 5 about the economic factors, Section 6 about the technological factor, Section 7 about environmental factors, and Section 8 about organizational factors. Last but not least, intension to use BIM in FM is questioned in Section 9.

3.4.3 Personal Demographic

The first section of questionnaire will be questioning about demographic data of respondents for us to briefly understand their personal background. There are a total of 7 questions to collect personal information such as gender, age, race, educational level, working country, working experience and profession.

3.4.4 BIM Adoption in Company

Meanwhile, in the second section we will have a simple BIM adoption level checking with questions of 'Is your company using BIM when conducting their projects?', 'Is your company planning to use BIM?', 'Is there one or more persons in your company interested in BIM?', 'At what BIM level is your company conducting their projects?' and 'What is the average cost of the projects you involved?'.

In this section, brief description of the functions and concepts of BIM is presented to assist respondents who previously have no knowledge regarding BIM and to complete the survey.

3.4.5 Variables and Respective Measurement Design

In the following sections, we will have simple and clear questions for respondents to answer based on a five-point Likert scale. Respondents can either pick the "Strongly Disagree", "Disagree", "Neutral", "Agree", or "Strongly Agree" to answer the question based on their opinion. Five-point Likert scale is applied throughout the section of questions on variables as it is the most often used scale, easy to understand, takes less time and effort to complete, and respondents can even give a neutral answer.

As TAM model is mainly focusing on acceptance at individual level which is more align with this study which analyze the perception on individual or employee in an organization, therefore the internal factors (perceived ease of use and perceived usefulness) are more focused. There are 8 questions in Section 3 to measure the perceived ease of use of BIM in FM, in terms of learning, inputting, updating, data retrieving, applying, understanding, completing tasks, and overall operating.

Section 4 contains of 14 questions in measuring the perceived usefulness of BIM in FM. The usefulness is measured based on enhanced collaboration between stakeholders, increased knowledge sharing and collaborative working, maintain success interoperability of building components, allow diversity management, facilitation of energy efficiency analysis, higher work efficiency, better idea presentation, better thinking illustration, better performance in retrieving information, better communication, facilitation of building system evaluation, better in achieving sustainable goal, higher productivity, and overall usefulness of BIM in FM.

However, questions for TOE which are the external factors more towards the organizational level are put at the next section. There are 4 external factors covered in this study which are economic factors, technological factors, environmental factors, and organizational factors. There are 4 questions about the economic factors in section 5, such as the capital outlays for the software, savings in building operation and maintenance cost, return on investment in long run, and absent of understanding of its implication by finance management professionals.

In terms of technological factors, there are 6 questions established in section 6. The questions are related to the speed, technology quality, IT support, functionality, result demonstrability, and feasibility of the software.

Meanwhile, requirement of national policies, model framework established by authority, intension of stakeholders to collaborate in utilizing it, its popularity, its competitive advantage, government support on it, government incentives to users, its providers, its accessible guidance, instruction, training and information, and its case study, all these elements are translated into the 10 questions under organizational factors in section 7.

Section 8 is about the organization factors. The measurement is constituted based on organization’s readiness and willingness, availability of technical infrastructure and expertise, capacity and financial affordability, risks and benefits to organization, with built up a total of 8 questions.

Last but not least, we are focusing on collecting feedbacks on the intension of respondent in adopting BIM in FM. The 6 simple questions are derived in this last section, section 9, for instance ‘Adoption of BIM in FM is a wise idea.’, ‘The adoption of BIM in FM is compatible with the operations in my workplace’, ‘The adoption of BIM in FM fitted well with the way if i want to do things in FM.’, ‘The adoption of BIM in FM would fulfill my needs.’ and ‘Assuming I had access to BIM, I intend to use it in FM.’ are included in this section.

Indicators cover factors like barriers, challenges, limitations, crucial success factors, motivational drivers, initiatives, and other BIM-related problems (Ahmed & Suliman). Through literature review on these relating factors, the measurements or indicators are listed, grouped and summarized under the variables based on the proposed framework as shown in the Table 3.1 below.

Table 3.1: Measurement Statements for Variables

Variables	Measurement / Indicator Statements	Citations
Perceived Ease of Use	I think learning to use BIM in FM is easy.	(Lai & Lee, 2020)
	I think the input of FM related information to BIM is easy.	-
	I think update of FM related information in BIM is easy.	-
	I think finding the information i need with BIM in FM is easy.	(Lai & Lee, 2020)
	I think becoming skillful at using BIM in FM is easy.	(Lai & Lee, 2020)

	I think all the accessible information regarding to BIM in FM are clear and understandable.	(Lai & Lee, 2020)
	I think it is easy for me to complete FM tasks with the aid of BIM.	-
	Overall, i find the use of BIM in FM is easy.	(Lai & Lee, 2020)
Perceived Usefulness	Implementation of BIM in FM would be helpful in enhance collaboration between stakeholders.	(Othman et al., 2020)
	Implementation of BIM in FM would be resulted in the increased knowledge sharing and collaborative working.	-
	Implementation of BIM in FM would be helpful in maintain success interoperability of building components throughout the building cycle.	(Othman et al., 2020)
	Implementation of BIM in FM would be helpful in allow diversity management.	(Othman et al., 2020)
	Implementation of BIM in FM would be helpful in facilitate energy efficiency analysis.	(Hoang et al., 2020)
	Implementation of BIM in FM would be resulted in an overall improvement of work efficiency.	(Hoang et al., 2020)

	Implementation of BIM in FM would be resulted in increased clarity in presenting an idea.	(Lai & Lee, 2020)
	Implementation of BIM in FM would be resulted in increased effectiveness in illustrating thinking.	(Lai & Lee, 2020)
	Implementation of BIM in FM would be resulted in better performance in retrieving information.	(Hoang et al., 2020)
	Implementation of BIM in FM would be resulted in easier communication with others.	(Lai & Lee, 2020)
	Implementation of BIM in FM would be helpful in building system evaluation.	-
	Implementation of BIM in FM would be helpful in achieving sustainable goal.	(Othman et al., 2020)
	Implementation of BIM in FM would be resulted in an overall improvement of productivity.	(Hoang et al., 2020)
	Overall, i find BIM is useful in FM.	(Lai & Lee, 2020)
Economical Factors	I feel implementing BIM requires huge capital outlays.	(Qin et al., 2020)
	I feel implementation of BIM in FM can help to save the operation and maintenance cost.	-

	I feel the return on investment of implementing BIM in FM can cover up the cost of implementation in long run.	(Qin et al., 2020)
	I feel there is an absence of understanding of BIM implication by finance management professionals.	-
Technological Factors	I feel the speed of BIM tools is sufficient.	(Van Tam et al., 2021)
	I feel the technology quality of BIM tools is good.	(Van Tam et al., 2021)
	I feel the IT support for BIM tools is good.	(Van Tam et al., 2021)
	I like the functionality / practicality of BIM tools.	(Van Tam et al., 2021)
	I like the result demonstrability of BIM tools.	(Van Tam et al., 2021)
	I think the implementation of BIM tools in FM is feasible.	(Van Tam et al., 2021)
Environmental Factors	BIM in FM is under requirement of national policies.	(Van Tam et al., 2021)
	There is a standard framework of BIM in FM established by authority as a model or criterion.	(Van Tam et al., 2021)
	Stakeholders intend to collaborate in the optimum utilization of BIM model in FM.	-

	Implementing BIM in FM is popular in my industry.	(Qin et al., 2020)
	Implementing BIM in FM helps my organization to gain competitive advantage compare to other companies.	(Van Tam et al., 2021)
	Government is supportive to BIM implementation in FM.	(Van Tam et al., 2021)
	There is government incentives to support BIM in FM.	-
	There are many BIM in FM providers in my country.	(Van Tam et al., 2021)
	There are a lots of accessible guidance, instruction, training and information about BIM software in FM.	-
	I think it is easy to find case study as a precedent to demonstrate BIM benefits in FM.	-
Organizational Factors	I feel my organization is ready to implement BIM in FM.	(Van Tam et al., 2021)
	I feel my oganization is willing to implement BIM in FM.	-
	My organization is having the necessary technical infrastructure to implement BIM in FM.	(Van Tam et al., 2021)

	My organization is having the capacity to implement BIM in FM.	(Van Tam et al., 2021)
	I feel the implementation of BIM in FM will benefits my organization.	(Van Tam et al., 2021)
	I feel my organization is financially affordable to implement BIM in FM.	(Van Tam et al., 2021)
	I feel my organization is having adequate expertise to implement BIM in FM.	-
	Implementation of BIM in FM is risky to my organization.	(Van Tam et al., 2021)
Intension to Use me	Adoption of BIM in FM is a wise idea.	-
	The adoption of BIM in FM is compatible with the operations in my workplace.	-
	The adoption of BIM in FM fitted well with the way if i want to do things in FM.	-
	The adoption of BIM in FM would fulfill my needs.	-
	Assuming I had access to BIM, I intend to use it in FM.	(Lai & Lee, 2020)
	In future, I intend to adopt FM-enabled BIM into my workspace.	-

3.4.6 Sampling Method and Sampling Size

This study is applying a purposive sampling method as the questionnaire is only sent to the targeted respondents who are working in the building and construction or relating industries, in the opinion that these practitioners are more familiar with the real-life implementation concerns of BIM in FM.

Due to the time constraint, the collected sample size is only 102 despite 200 questionnaires were distributed out. A sample size of 100 is considered small, 100-200 is medium, however a sample size of below 100 is not recommended to represent the outcome of any SEM model unless it is a very simple model (Kline, 2016). As for purposive sampling, there is no guideline for the required number of samples, and the researcher has the freedom in designing the sample size which can serve the purpose of study. The more important factor affecting the accuracy is the selected samples instead on the sample sizes, for instance a carefully selected sample of size 150 and above is having a greater presentation than a random sample of size 300 and above.

3.5 Data Collection

Data collection can be classified into primary data collection and secondary data collection. The term "primary data" refers to the first-hand information which is collected directly by the researcher himself. However, the term “secondary data” is referring to information which is gathered earlier by another party for instance the data retrieved from questionnaires, personal interviews, observations, experiments, online publications, websites, books, journal papers, and other documents.

Primary data is adopted in this study as questionnaires will be distributed out by research to the target respondents who are working in facility, property, construction and building industry, to collect their responses towards the BIM implementation in facilities management. Due to the consideration of ongoing Covid-19 endemic where some companies might be practicing work from home or hybrid working mode, an online questionnaire survey will be the best method in data collection. At the same time, it is also the best way to reach dozens of people from various location within shortest time. The data is collected within the period of a month.

A Google form will be used and distributed through online platform such as WhatsApp, Facebook, Microsoft Teams and email. We are choosing to adopt Google form as the software is free and user-friendly. At the same time, the form could be easily sent out via a link. The most important reason of choosing to use Google form is because the answers of the respondents can be exported in an excel file and directly used for further analysis which helps us to save a lot of time as compared to manual key in.

3.6 Data Analysis

3.6.1 Descriptive Statistics Analysis

Descriptive statistics analysis is applied to explain the personal demographic and basic company background information about BIM use in the company. As there is a built-in function of displaying summary output in pie chart form in the google form, therefore the pie charts are directly extracted and applied as materials for descriptive statistics analysis in this study without the need to manually plot of other statistical graphs.

3.6.2 Inferential Statistics Analysis

Partial Least Squares Structural Equation Modelling (PLS-SEM) is used to draw conclusions and predictions based on the findings data. PLS-SEM is also known as PLS Path Modelling, which is a modelling method used to analyse of multivariate data and examine the latent variables in the models (Memon, Ramayah, Cheah, Ting, Chuah & Cham, 2021). Moreover, PLS-SEM modelling can also be done in Smart PLS software.

SmartPLS is a popular assisting tool applied by researchers in the field of business and social science to calculate, create, and validate models. It is highly adopted due to its user-friendly visual interface, at the same time multiple robustness assessments can be done while taking into account the measurement error inherent in the evaluation of abstract and complex concepts. (Memon et al., 2021).

In short, data analysis is done by applying of PLS-SEM analysis method with the aid of SmartPLS software.

The survey data collected in google form is exported in excel file and import to the SmartPLS after some minor formatting adjustment. The framework model of this study is then input in the software to run analysis on basic PLS-SEM algorithm and further bootstrapping with 5000 sub samples. Analysis in terms of composite reliability, convergent validity and discriminant validity are done to validate the measurements and assess the hypothesis.

First of all, composite reliability, in other words, the construct reliability, which is a checking on the consistency of the scale items is carried out. Composite reliability is extracted instead of Cronbach's Alpha value which displayed a lower limit than genuine reliability, even though application of any value shouldn't have a negative impact on the advancement of knowledge (Peterson & Kim, 2013). The composite reliability value of a variable must fall above 0.7 to show that the internal items are consistent. However, values above 0.95 are representing redundant indicators. In other words, a rephrased inquiry is repeated in measuring the same occurrence therefore having error term correlations and negative effects on the measures' content validity (Hair, Hult, Ringle & Sarstedt, 2017).

Moving forward, two essential components of construct validity are convergent and discriminant validities. Convergent validity assesses how well the scale correlates with other variables and measures of the same construct. Since the construct should only be correlated with similar, related factors, but not correlated with dissimilar, unrelated ones. Convergent validity, can be assessed based on value of outer loadings. The value of outer loading should be above 0.5 for business and social science study to show that the item is convergence valid.

On the other hand, Average Variance Extracted (AVE) is the measure variance captured by a construct in relation to variance in measurement error. AVE value must be greater than 0.5 to proof the discrimination validity. Meanwhile, there is another alternative approach applied to measure the discrimination validity, which is based on the HeteroTrait-MonoTrait ratio of correlations (HTMT). The HTMT value must be below 0.90, to reflect the variable is discriminant valid.

Furthermore, the test of relationship between variables is done by T-test and P-test. T-test is a statistical tool used to examine means, standard deviations, and skewness of two groups of data to determine whether there are statistically significant differences. In short, for the research study, the greater the T-value, the greater the difference between the hypothesis and null hypothesis.

The test must be coupled with a P-test to further test on the null hypothesis. P-value is representing the probability of obtaining the t-value and if the null hypothesis is accepted. The P-value must be lesser than a 0.05 to reject null hypothesis and resulting in significant and supported hypothesis. In opposite, the obtained T-value is not significant and rejected as it might be just a random observation if the P-value is high. Path coefficient is also recorded to show the influence level and whether it is positive or negative effect between the variables.

Last but not least, the R^2, coefficient of determination, is the final test on how well the model explains the observed data. The closer the value to 1, the greater the data to fit the regression model. It is also named as goodness of fit test, as it functions to test the model on its degree of agreement between prediction results and the actual situation. According to Hair, Ringle and Sarstedt (2011), the model with R^2 value of 0.75 and above is a strong model, 0.5 – 0.75 is moderate model, 0.25 – 0.50 is a weak model, and below 0.25 is a very weak model.

3.7 Conclusion

As a conclusion for Chapter 3, this research is basically a quantitative research where 102 sets of questionnaire responses are collected and analyzed in PLS-SEM method. All the methodologies applied throughout the research has been divided into 5 stages, which begins with identification of research issue and problem statement, moving forward to literature review, and followed with research design, data collection and data analysis. Explanation of each stage in the research will be covered. Details of method applied in each stage are justified and explained in this chapter.

CHAPTER 4

DATA ANALYSIS

4.0 Introduction

The analysis is done based on the data collected from the questionnaire. All the results and findings are presented in the form of tables, graphs and charts in this chapter together with appropriate elaborations and interpretations which are made to justify the results and findings. For instance, descriptive statistical analysis result is under sub-chapter 4.1, inferential statistical analysis result is under sub-chapter 4.2, and a brief conclusion is under sub-chapter 4.3.

4.1 Descriptive Statistical Analysis Result

Descriptive statistical analysis is done based on demographic of the respondents for instance the gender, age, race, education level, working country, working experience and profession. Meanwhile, basic information about their company is also presented in this sub-chapter, for example the actual BIM use in company, intension of company management to use BIM, intension of company employees to use BIM, actual level of BIM use in company and cost of projects involved.

Pie chart extracted from google form survey summary are applied to assist readers to quickly understand the data. As the total percentage is 100%, and the total number of respondents is 102, therefore every percent displayed in the pie chart is representing or equal to a respondent.

4.1.1 Gender

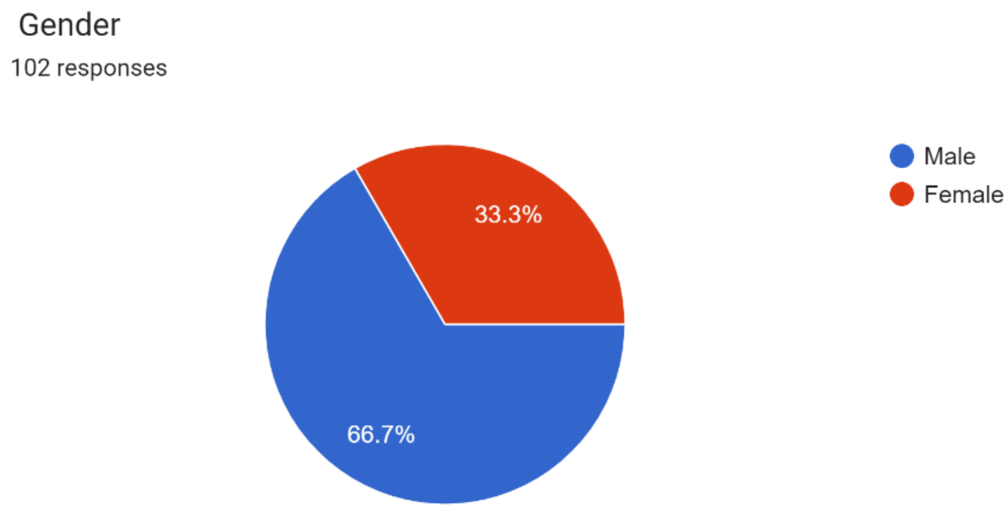

Figure 4.1: Respondents' Gender Distribution

The questionnaire is randomly sampled to the practitioners working in AEC industry, and the data collected is acceptable as the collected result of gender distribution is corresponding to the norm where there is higher employment rate of male comparing to female in AEC industry. Based on the Figure 4.1 above, there are a total 102 responses collected in this study, where one-third is from female (33.3%) and two-third (66.7%) is from male. There is a statement saying that employment of female is lesser than 10% in construction sector (Rahim, 2022). The greater percentage of female respondents than the statement might due to greater numbers of female are based in office and therefore higher chance to receive the questionnaire and responded by filling it up.

4.1.2 Age

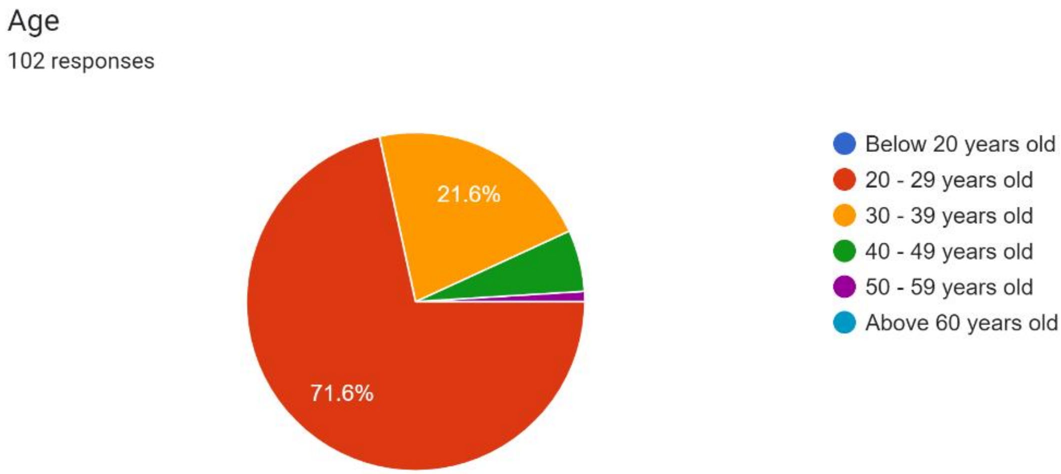

Figure 4.2: Respondents' Age Distribution

The majority of the respondents are within 20-29 years old, which constitutes 71.6%, followed by respondents within the age of 30-39 years old which constitutes 21.6%, and another 5.9% are within the age of 50-59 years old. The data of age distribution showed that the respondents are the suitable population to be surveyed, as the majority of respondents are youngsters in the age between 20 – 29 as illustrated in pie chart of Figure 4.2 above. These age group of people tends to play an important role in development of future technologies. Followed by mid-age practitioners in the age 30 - 39, where they perceptions are practical and critical. Meanwhile, their feedbacks are vital in order to know the actual level of adaptability to new technology by this group of people.

4.1.3 Race

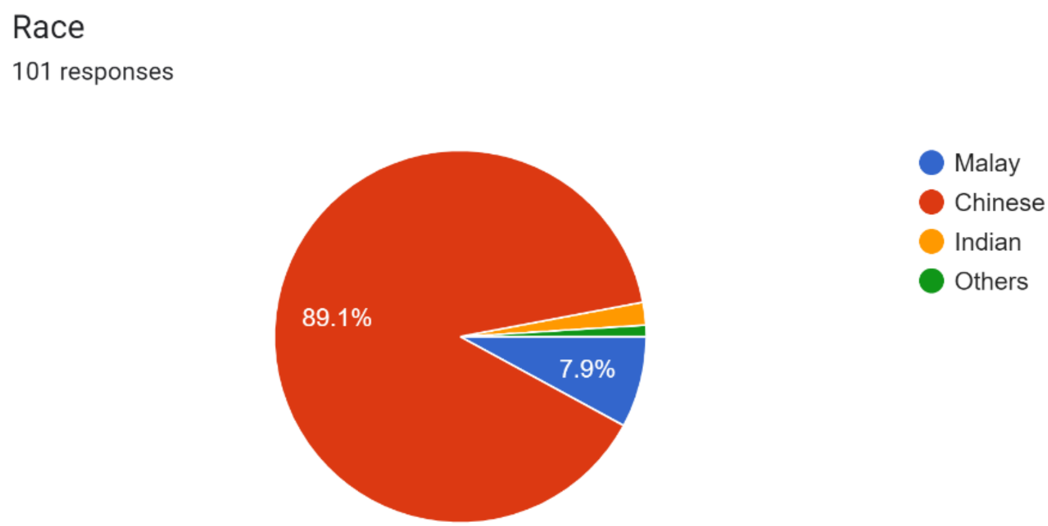

Figure 4.3: Respondents' Race Distribution

As the questionnaire is distributed to colleagues, friends, acquaintances, who are working in the same company or industry, therefore the respondents are biased to one race. Based on the respondents' race distribution in Figure 4.3 above, the Chinese (89.1%) are the main majority of the respondents, followed by Malay (7.9%), Indian (2%), and others (1%). This has showed that the exposure of this study to other races is limited.

4.1.4 Education Level

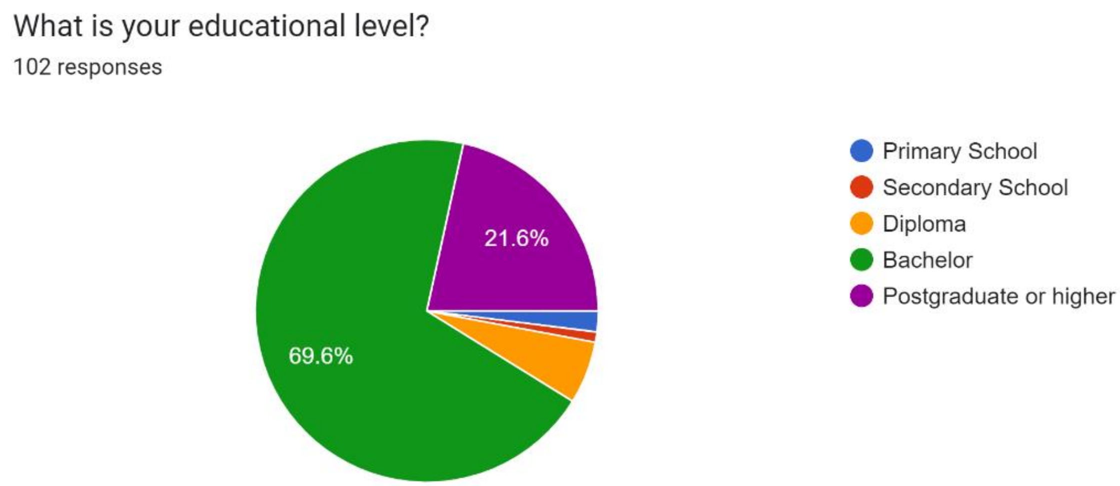

Figure 4.2: Respondents' Education Level Distribution

According to respondents' education level distribution in Figure 4.2 above, majority of the respondent is having a Bachelor level of education (69.6%), followed with Postgraduate (21.6%), and Diploma (6%) which are suitable to be accounted into this research as the implementation of BIM in FM requires great amount of technical knowledge and fundamental understanding of FM tasks, therefore education level of Diploma and above is opined to be the minimum requirement. Meanwhile, there are also few respondents with primary and secondary school education level responded, as the survey might reach to site personnel where the requirement on their education level might be lower. Nevertheless, their perception towards the study topic is also taken into account.

4.1.5 Working Country

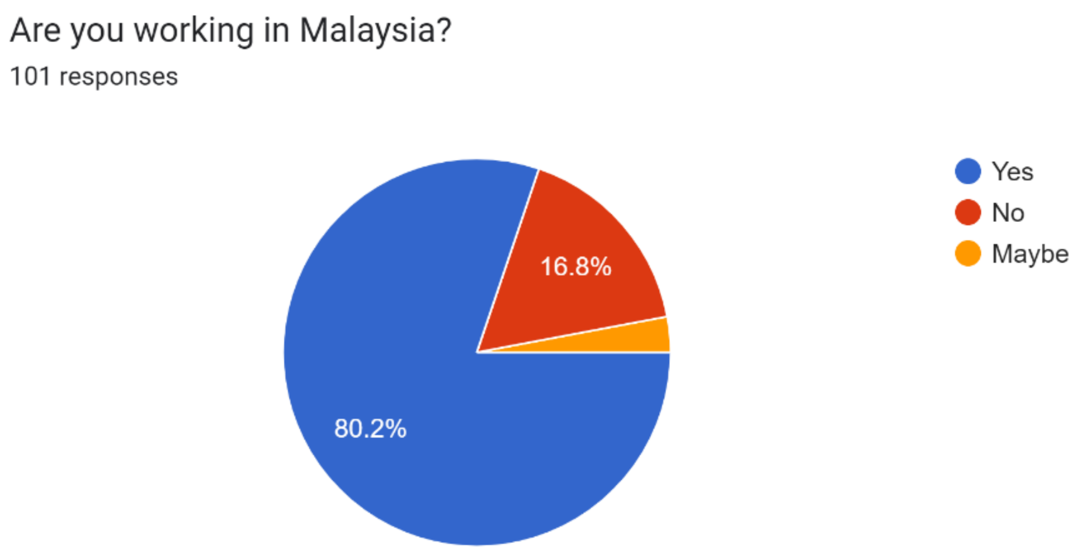

Figure 4.5: Respondents' Working Country Distribution

Based of the pie chart of working country distribution above in Figure 4.5, 80.2% are working in Malaysia, 16.8% are not working in Malaysia, and 3% out of total respondents are not confirmed which might because the projects or jobs they are involved require them to have frequent travel or relocation therefore they are uncertain of their working country. The research is mainly focus on respondents from Malaysia, however, the responses from workers working in oversea are remained and taken into account in this study. The reason is because the questionnaire is purposively distributed to Malaysian only, and therefore the opinion of Malaysians working in other countries are not being excluded.

4.1.6 Working Experience

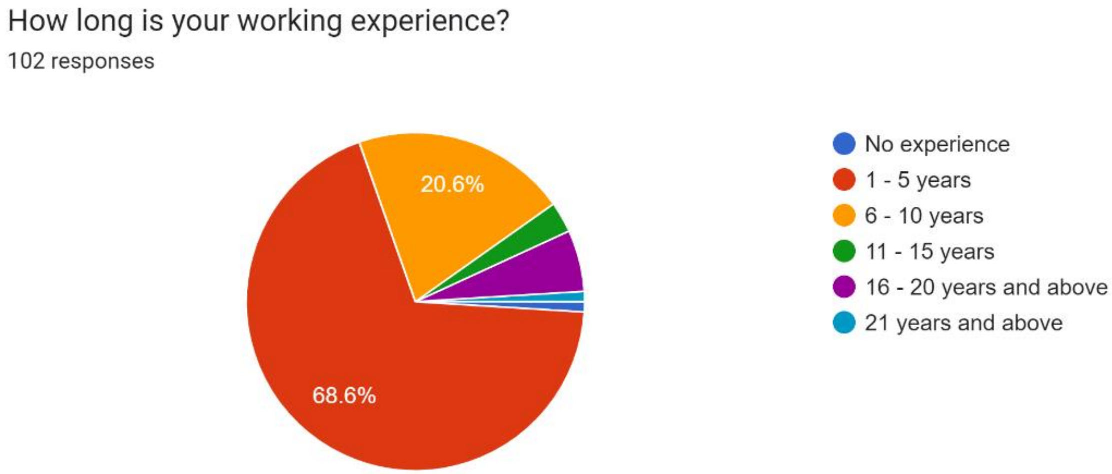

Figure 4.6: Respondents' Working Experience Distribution

The working experience of the respondents can be used as evidence to proof that their perception is valuable. In this study, 68.6% of the respondents are having 1- 5 years of working experience, followed by 20.6% of the respondents are having 6 - 10 years of working experience, 5.9% of the respondents are having 16 - 20 years of working experience, 1% of the respondents are having no working experience and another 1 % of respondents is having more than 20 years of working experience as shown in Figure 4.6 above. It is acceptable, as majority are having some working experiences.

4.1.7 Profession

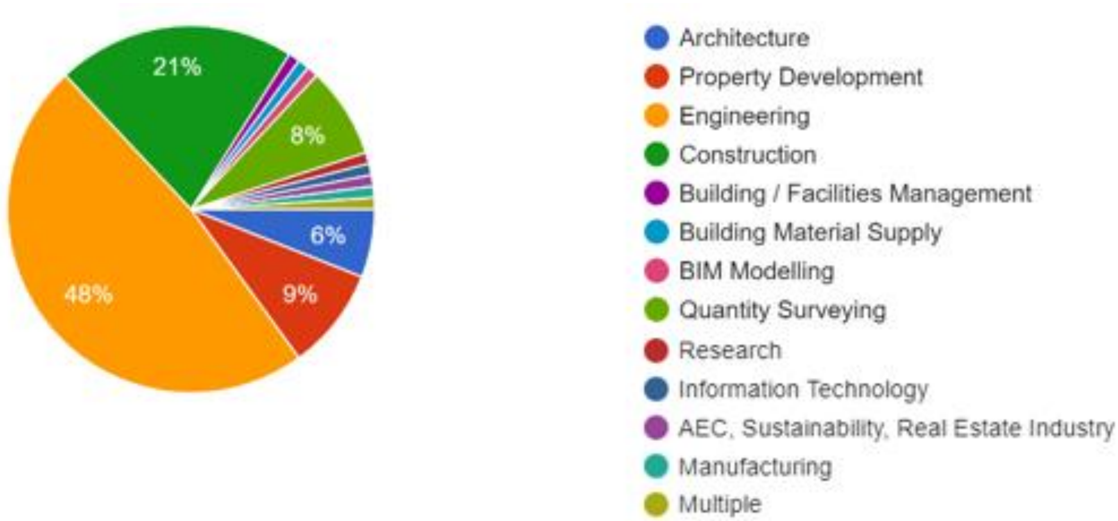

Figure 4.7: Respondents' Profession Distribution

Based on the data collected as shown in Figure 4.7 above, it is showed that almost half of the respondents are profession in engineering (48%), followed by construction (21%), property development (9%), quantity surveying (8%), architecture (6%), building / facilities management (1%), building material supply (1%), BIM modelling (1%), research (1%), information technology (1%), sustainability real estate industry (1%), manufacturing (1%), and multiple professions (1%).

4.1.8 Average Cost of Projects Involved

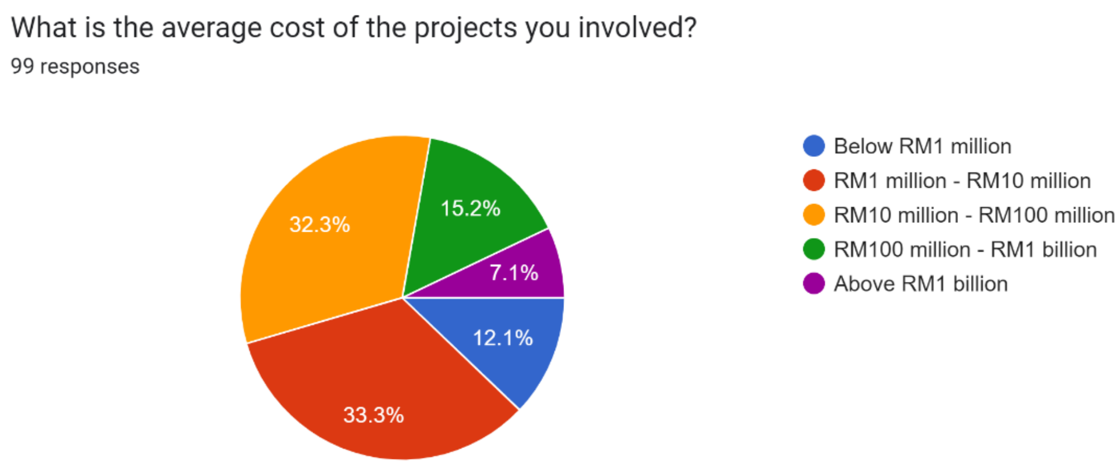

Figure 4.8: Average Cost of Projects Involved Distribution

As BIM is under compulsory requirement to be implemented for projects with value above certain amount, therefore the data about the average cost of projects involved is surveyed and recorded as shown in Figure 4.8 above. According to the respondents, most of them rated that their projects average cost within RM1 million - RM 10 million (33.3%), followed by RM 10 million – RM 100 million (32.3%), RM 100 million – RM 1 billion (15.2%), below RM1 million (12.1%), and lastly above RM 1 billion (7.1%).

4.1.9 Basic Information about BIM Use in Company

Table 4.1: Summary of Basic Information about BIM Use in Company

Is your company using BIM when conducting their projects?	
Yes	48.0%
No	44.1%
Maybe	7.8%
Is your company planning to use BIM?	
Yes	49.0%
No	26.5%
Maybe	24.5%
Is there one or more persons in your company interested in using BIM?	
Yes	72.5%
No	12.7%
Maybe	14.7%
At what BIM level is your company conducting their projects?	
3D	40.6%
4D: (3D + Construction Process Scheduling)	14.9%
5D: (4D + Costing)	5.0%
6D: (5D + Energy Consumption Monitoring)	2.0%

7D: (6D + Lifecycle Performance Assessment)	1.0%
None of above	36.6%

Based on the data in the Table 4.1 above about the summary of basic information of BIM use in company, it is showed that there are more positive responses towards BIM adoption. Out of total, there are 48% of responds stating that their company has started using BIM to conduct their projects, 44.1% of them are not, and 7.8% are unknown. Meanwhile, 49% is planning to use BIM, 26.5% is not having the plan to use BIM and 24.5% are not confirm on this, which showed that there is a possibility of higher adoption in future despite they are not confirm on it at the moment.

On the other hand, 72.5% of the responses showed that there is one or more employees interested about the implementation, while only 12.7% had answered no, and 14.7% of the respondents have no idea on it. Despite there is a high percentage of intension of employees in implementing BIM, most of the company is only using BIM at the level of 3D which accounts for 40.6%, and another 14.9% of them is using BIM up to level of 4D. Moreover, 36.6% of the responses is stating that none of any BIM level is implemented in their company. Also, based on the data collected, the implementation of BIM in 5D is only 5%, 6D is 2% and 7D is 1%.

4.2 Inferential Statistical Analysis Result

Inferential statistical analysis is done and the result is tabulated and explained in this section.

4.2.1 Graphical Output of PLS-SEM Model

First and foremost, the graphical output of PLS-SEM model is extracted from SmartPLS software as shown in Figure 4.9 below.

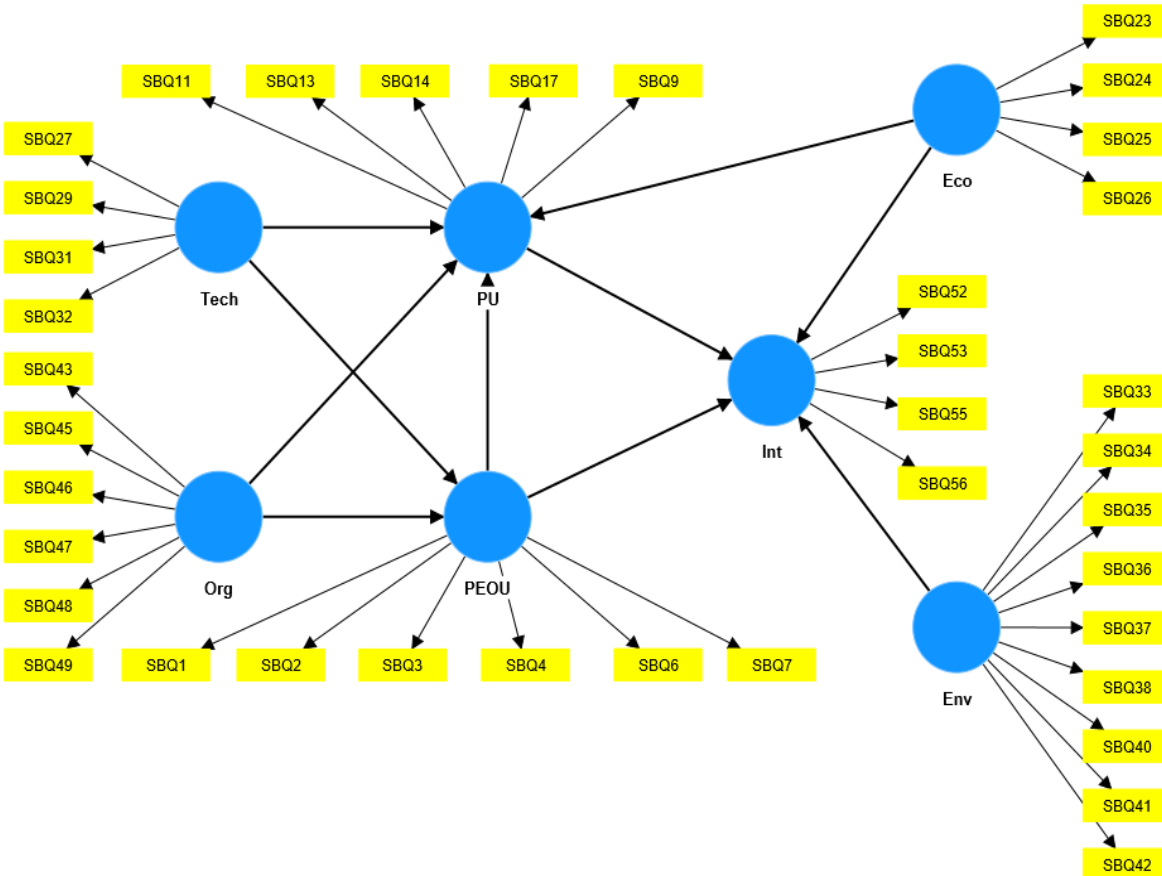

Figure 4.9: Graphical Output of PLS-SEM Model Extracted from SmartPLS

4.2.2 Validity and Reliability Test Result

Table 4.2: Validity and Reliability Test Result Extracted from SmartPLS

Variable	Items	Outer Loadings	Composite Reliability	AVE
Perceived Ease of Use (PEOU)	PEOU_1	0.821	0.947	0.748
	PEOU_2	0.863		
	PEOU_3	0.908		
	PEOU_4	0.867		

	PEOU_5	0.877		
	PEOU_6	0.850		
Perceived Usefulness (PU)	PU_1	0.876	0.951	0.794
	PU_2	0.914		
	PU_3	0.878		
	PU_4	0.879		
	PU_5	0.908		
Economic Factor (Eco)	Eco_1	0.680	0.857	0.602
	Eco_2	0.841		
	Eco_3	0.791		
	Eco_4	0.782		
Technological Factor (Tech)	Tech_1	0.867	0.941	0.801
	Tech_2	0.919		
	Tech_3	0.877		
	Tech_4	0.915		
Environmental Factor (Env)	Env_1	0.600	0.922	0.571
	Env_2	0.674		
	Env_3	0.714		
	Env_4	0.813		

	Env_5	0.731		
	Env_6	0.853		
	Env_7	0.687		
	Env_8	0.885		
	Env_9	0.798		
Organizational Factor (Org)	Org_1	0.864	0.948	0.752
	Org_2	0.890		
	Org_3	0.931		
	Org_4	0.755		
	Org_5	0.884		
	Org_6	0.872		
Intension to Use BIM in FM (Int)	Int_1	0.888	0.934	0.781
	Int_2	0.911		
	Int_3	0.809		
	Int_4	0.923		
	Int_5	0.674		
	Int_6	0.714		

Convergence validity evaluation is done based on the outer loading value. In Table 4.2 above, the outer values for all the items above are above 0.5 which shows that the items are all convergent valid to be included in the study. Furthermore, the composite reliability values for all variables are above 0.7 which shows that the underneath scale items are consistent and reliable. Besides, the AVE value of above 0.5 is again proofing that all the variables are having high reliability. On the other side, AVE also functions as a discrimination validity test. Together with the HTMT below in Table 4.3, which is an alternative proof of the discrimination validity, all the data variables are proved to be discrimination valid with HTMT value below 0.90.

The only concerning part is the composite reliability value of PU of 0.951 slightly higher than 0.95, the result of over high reliability is indicating that the indicators might be redundant and therefore reduce the construct validity. However, after the consideration, the indicators are opined not in redundant after reviewing, therefore remained in the model to proceed with the analysis.

Table 4.3: HTMT Result Extracted from SmartPLS

	Eco	Env	Int	Org	PEOU	PU	Tech
Eco							
Env	0.301						
Int	0.840	0.430					
Org	0.626	0.482	0.758				
PEOU	0.877	0.218	0.816	0.570			
PU	0.837	0.139	0.653	0.408	0.752		
Tech	0.898	0.274	0.737	0.587	0.862	0.760	

4.2.3 Hypotheses Test Result

Table 4.4: Hypothesis Test Result Extracted from SmartPLS

Path	Path Coefficient	T-value	P-value	Hypotheses
H1 : PEOU -> Int	0.476	4.677	0.000	Supported
H2 : PEOU -> PU	0.292	1.821	0.069	Reject
H3 : PU -> Int	0.03	0.307	0.759	Reject
H4 : Env -> Int	0.265	3.947	0.000	Supported
H5 : Eco -> Int	0.282	2.408	0.016	Reject
H6 : Eco -> PU	0.354	3.038	0.002	Supported
H7 : Tech -> PU	0.258	1.651	0.099	Reject
H8 : Tech -> PEOU	0.727	9.792	0.000	Supported
H9 : Org -> PU	-0.102	1.555	0.120	Reject
H10 : Org -> PEOU	0.134	1.844	0.065	Supported

The summarized hypotheses testing results are shown in Table 4.4 above. Path coefficient is representing the effect of independent variable to dependent variable. A positive path coefficient is indicating a positive encouraging effect; a negative path coefficient is indicating a negative inhibiting effect instead. On the other hand, T-test is always coupled with P-test to test where a hypothesis is supported or rejected. To achieve 95% confidence level or 5% alpha, the T-value must be above 1.96, and the P-value below 0.05 to support the hypothesis.

Among the 10 formed hypotheses, only 5 of them are supported which are the H1, H4, H6, H8 and H10 that having significant and positive effect. Meanwhile, the 3 hypotheses H2, H3, H5, H7 and H9 are rejected as no significant effect are observed.

Based on the result, the Model is revised with removing of unsignificant relationship. Figure 4.10 below is the outcome model after the analysis of data collected for this study.

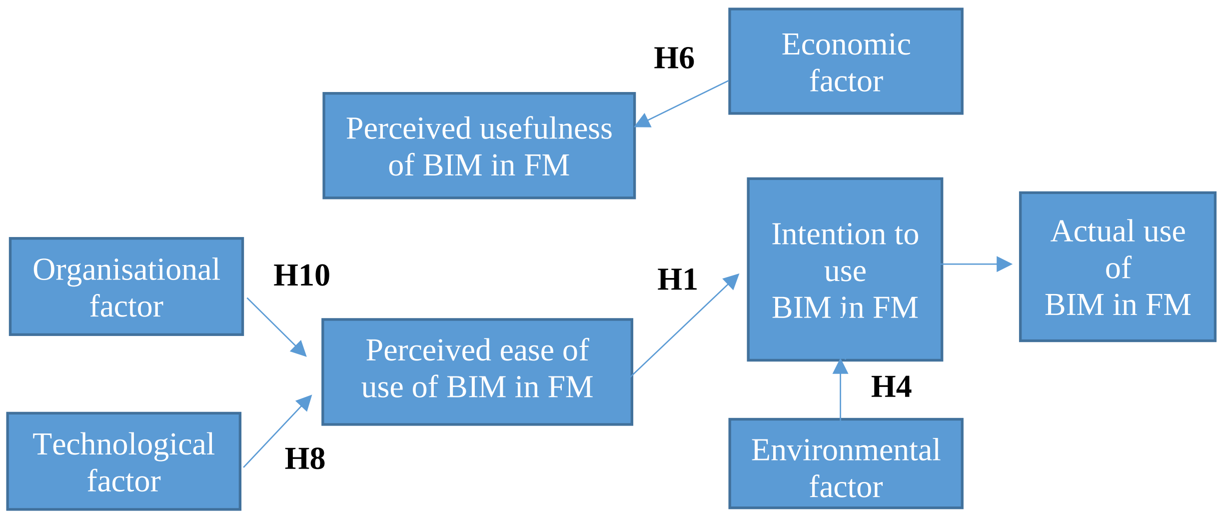

Figure 4.10: Outcome Model

4.2.4 Coefficient of Determination Test Result

Table 4.5: Coefficient of Determination Result Extracted from SmartPLS

	R^2
Int	0.683
PEOU	0.653
PU	0.603

Based on the Table 4.5 above, the coefficient of determination, the R^2 value of the dependent variables are displayed. The results of model in this study are considered in moderate category, as the R^2 value of intension to use is 0.683, perceived ease of use is 0.653 and perceived usefulness is 0.603.

4.3 Conclusion

As a recap of data analysis for Chapter 4, the demographic and basic information about the BIM use in company are presented in a descriptive statistical analysis form. Furthermore, in the inferential statistical analysis part, all the indicators and variables are modelled and tested with the aid of SmartPLS to show the validity and reliability. After that, the hypotheses test using the T-test and P-test is done to come out with the supported hypotheses as listed below:

H1: There is a positive relationship between perceived ease of use toward intension to use BIM in FM.

H4: There is a direct relationship between environmental factor and intension to use BIM in FM.

H6: There is a direct relationship between economic factor and perceived usefulness of BIM in FM.

H8: There is a direct relationship between technological factor and perceived ease of use of BIM in FM.

H10: There is a direct relationship between organizational factor and perceived ease of use of BIM in FM.

CHAPTER 5

CONCLUSION

5.0 Introduction

Chapter 5 is a conclusion chapter for the entire research. It consists of discussions on major findings, implications of the study, limitations of the study and recommendations for future research.

Based on the results obtained in Chapter 4 and literature reviews of related papers, factors affecting the perception, and influences of the perception towards the implementation of BIM in FM are summarized and discussed in this chapter. Furthermore, implications are concluded to highlight the major outcome of the research. On the other side, limitations are clearly defined to clarify on the scope covered. Last but not least, recommendations for future research are included to assist and welcome more researchers to conduct their studies in related with this topic.

5.1 Discussions on Major Findings

It was found that the actual implementation rate of BIM in FM is relatively low. In this subsection, the relationships between the independent variables to the dependent variables are evaluated and further discussions will be made to justify and explain on the supported hyphotheses.

5.1.1 Perceived ease of use increases intension to use BIM in FM

The positive relation of perceived ease of use towards the intension to use BIM in FM is found to be significant, however the effect of perceived ease of use towards perceived usefulness and perceived usefulness towards intension to use are insignificant. This finding is supported by another study by Zhao et al. (2022), which also found a not significant result of perceived ease of use towards perceived usefulness; and perceived usefulness is also having insignificant influencing to intension of implementing BIM as well.

This has proven that the ease of use is the main driving factor of a technology acceptance in the perception of individuals. Users are more likely to adopt new technology which is user-friendly while perceived usefulness plays a less important role here in affecting the intension to adopt BIM in FM. This result is making sense as users might feel carefree, less risky and therefore having confident and willing to try on adopting and adapting a simple tool which is entirely new to them.

As an outcome in this study, this hypothesis highlighted that in order to increase intension to use BIM in FM, the BIM software must be easy to learn and input. The update of FM related information should be also be simple. Moreover, the accessible information regarding FM should be clear and understandable, so that the facilities managers can find the information they need easily, hence completing their tasks with trouble-free.

5.1.2 Environmental factor drives intension to use BIM in FM

On the other hand, the external factor which directly induced a positive relationship toward the intension to use BIM in FM is the environmental factor. This might due to the environment factor is more like the opportunity or threat that directly influence the intension of implementation.

Based on the data collected in this study, the indicators under the environmental factor are for example, whether the BIM is under requirement of national policies, is there standard framework established by authority as a model or criterion, is government being supportive to BIM implementation, are stakeholders intend to collaborate and implement it. Other than that, are there many BIM providers found in the country, accessible guidance, instruction, training and information, case study as a precedent to demonstrate the BIM software in FM. Moreover, the popularity of BIM in FM in industry, and the competitive advantage gained by its implementation as comparing to other companies are also categorized under the external factors which drive the intension to use BIM in FM.

5.1.3 Economic factor drives perceived usefulness of BIM in FM

Economic factor was found to have direct relationship towards perceived usefulness of BIM in FM instead of towards the intension of implementation. This might due to the economic factor is linked to the perceived cost benefit, in other words, the perceived usefulness in terms of financial. While this economic factor is not necessary influence on the intension of implementation of BIM in FM.

There are a total of 4 indicators under the economic factor, which are the capital outlays of BIM software, saving in operation and maintenance cost after the implementation, return on investment in long run and most importantly, the understanding level of BIM implication by finance management professionals. These indicators under economic factors are found to positively influence the perceived usefulness of BIM in FM.

5.1.4 Technological factor drives perceived ease of use of BIM in FM

Technological factor was found to increase the perceived ease of use of BIM in FM instead of the perceived usefulness. This might because people are feeling that the better the technological performance of BIM, the easier the operation of BIM in FM. For instance, the speed of BIM, IT support of BIM, result demonstrability of BIM, and technological feasibility of BIM tend to increase the perceived ease of use of BIM in FM. This finding is also same with the finding in the study of Zhao et al., (2022) where BIM technical features show a positive relationship with the perceived ease of use.

5.1.5 Organizational factor drives perceived ease of use of BIM in FM

Similarly, another finding of Zhao et al. (2022), is again proven in this study, which the organizational factor is having positive relationship with perceived ease of use. Organization factor is found to be another driving factor which affecting the perceived ease of use of BIM in FM, as the BIM software must complement with the organization then only the perceived ease of use is achieved.

First of all, the organisation must be ready for its implementation and the implementation must be complement and beneficial to the organization. The necessary infrastructure, capacity, financial ability, adequate expertise are also indicators which influence the perceived ease of use of the BIM in FM.

5.2 Implications of the Study

The implications of this study can be divided into two categories, one is the implications for researches and another one is the implications for practitioners.

5.2.1 Implications for Researchers

The finding in this study is able to proof the validity of TAM-TOE framework and the suitability of this acceptance model framework in finding the factors that influence the intension to use BIM in FM. Meanwhile, economic factor, as an additional factor is also proven as a significant factor in influencing the perceived usefulness and therefore should be added into the TAM -TOE framework.

5.2.2 Implications for Practitioners

Despite of countless advantages of BIM in FM has been acknowledged by researchers, however, the actual implementation of BIM in FM in practice is still at infancy stage. Therefore, this research is having a great implication to act as a guideline to the BIM developer by establishing the factors which mainly influence on the intension to use BIM in FM. The insignificant factors can be filtered out, hence only the influencing factors are focused. Based on the influencing factors, the software can be improved and designed to match with the market’s requirement.

For instance, the finding has showed that the ease of use is the main driving factor of the intension to use BIM in FM. The BIM developer should focus on the ease of use of the software. Also, the technology factor and organizational factor are influencing on the ease of use of software, therefore the design of software should have good technological performance and compatible to organization at the meantime. Enhancing of the interoperability is one of the effective strategies that must be focused in order to increase the adoption rate of BIM in FM.

Aside to policy makers, environmental is also a factor influencing to intension to use BIM in FM. Therefore, policies, guidance, and support should be drafted and planned in order to promote the adoption of BIM in FM. For instance, provision of standard framework or model of FM-BIM software, government incentives, training and information about BIM software in FM are required to introduce the software to the public and make it popular among all the stakeholders.

Another finding is the economic factor was found to only have significant effect on the perceived usefulness of BIM in FM. However, the relationship of perceived usefulness to intension of implement BIM in FM is found to be insignificant. In other words, the benefit of operational and maintenance cost savings by implementing BIM, and the perceived usefulness of BIM in FM is not having any obvious boost to the intension of implementation of BIM in FM.

With the findings above, practitioners are able to know directions and aspects where improvement strategies should be focused on in order to increase the adoption rate of BIM in FM.

5.3 Limitations of the Study

Despite the outcome of this research is able to deliver sufficient insight of the perception on the implementation of BIM in FM with the aim to improve its adoption rate. However, there are some limitations which are not addressed in this research. These limitations are discussed in this sub chapter.

The first limitation of the study is the collected questionnaire might be too less to represent the actual BIM implementation perception of the whole crowd over the country, as only 102 responses are collected within a month of time. In addition, since the purposive sampling method is adopted in this study which means the questionnaire was only sent to the targeted population, the opinions of the public outside the targeted population are not covered. Therefore, the result of this research might be biased.

Furthermore, based on the data collected, the majority of the company is only using BIM up to the level of 3D modelling, and many of them are yet to implement BIM in their company. However, in order to achieve the best implementation of BIM in FM and best use of BIM in FM, a level of 7D must be reached which included the functions of energy consumption monitoring and lifecycle performance assessment. However, only 1% rated that they are using the BIM in a level of 7D. The low implementation rate and low level of BIM implementation shows that the majority might not having the actual experience in using BIM in FM, therefore there is a concern that their perceptions or predictions might not in good representation of the real case.

On the other hand, only 1% of the respondents is the profession of building or facilities management which is far lesser than respondents working in other relating professions. The FM is relatively new in Malaysia with unclear definition on their job-scope, different facilities manager tends to have different job-scope. Without a clearly stated job-scope, the research of implementation of BIM in FM is only be a broad topic without going to detail and focusing on any of the specific FM tasks and having a precise outcome to deal the tasks.

Besides, the hypotheses formed in this study is rather direct and simple without considering of the mediating or moderating effects. Despite the aim of the study is achieved, however, there is a possibility of ignorance on some indirect effects during variables.

Last but not least, the actual implementation should be more depends on the management and organization level, as the organization's management is the one to decide whether to implement BIM in FM or not. However, the questionnaire is only collecting the responses from ground level individual users, where their perceptions might be different with the perception of the organization's management. Also, the relationship between the intension to BIM in FM and the actual adoption of BIM in FM is not covered in this study.

5.4 Recommendations for Future Research

To address the limitation of this study, future researches are recommended to be carried out to collect information from different perspectives, especially from the organizational management point of view. Researches with other types of sampling method, different size, different targeted population are also suggested to validate the research findings in this study. It is also recommended to study with different models which covered of different factors in order to deliver a more comprehensive outcome. Mediating and moderating effects should also be incorporated to improve the accuracy of the study. Moreover, the relationship between the intension to BIM in FM and the actual adoption of BIM in FM should be measured.

REFERENCES

A CONSTRUCTION PRODUCTIVITY MAGAZINE. (2011). *Building and Construction Authority*. http://www.bca.gov.sg

Abd Rashid, N. F. (2020, September 30). Govt Aims 80% Adoption of BIM System By 2025. *myBIM Portal*. Retrieved October 31, 2021, from https://mybim.cidb.gov.my/govt-aims-80-adoption-of-bim-system-by-2025/

Abuimara, T., Hobson, B. W., Gunay, B., O'Brien, W., & Kane, M. (2021). Current state and future challenges in building management: Practitioner interviews and a literature review. *Journal of Building Engineering*, *41*. https://doi.org/10.1016/j.jobe.2021.102803

Ahmed, S. H. A., & Suliman, S. M. A. (2020). A structure equation model of indicators driving BIM adoption in the Bahraini construction industry. *Construction Innovation*, *20*(1), 61–78. https://doi.org/10.1108/CI-06-2019-0048

Alavi, S. H., & Matheu, N. F. (2019). BIM LOD for facility management tasks. *Proceedings of the 2019 European Conference on Computing in Construction*, *1*, 154–163. https://doi.org/10.35490/ec3.2019.187

Arif, N. K., Hasmori, M. F., Deraman, R., Yasin, M. N., & Mohd Yassin, M. A. (2021). Readiness of Malaysian Small and Medium Enterprises Construction Companies for Building Information Modelling Implementation. *IOP Conference Series: Materials Science and Engineering*, *1200*(1). https://doi.org/10.1088/1757-899x/1200/1/012027

Awang, M., Mohammed, A. H., Md. Shalleh, M. N., Johari, N. H., & Khair, N. (2017). Facilities Management-Future Prospect in Malaysia. *Penerbit UTM Press.* www.sainshumanika.utm.my

Aziz, N. D., Nawawi, A. H., & Ariff, N. R. M. (2016). ICT Evolution in Facilities Management (FM): Building Information Modelling (BIM) as the Latest Technology. *Procedia - Social and Behavioral Sciences, 234,* 363–371. https://doi.org/10.1016/j.sbspro.2016.10.253

Azzran, S. A., Tah, J. H. M., & Abanda, H. (2018). DEVELOPING BIM-FM INNOVATION TECHNOLOGY ACCEPTANCE FRAMEWORK. *Journal of Building Performance, 9*(1). http://spaj.ukm.my/jsb/index.php/jbp/index

Belay, S., Goedert, J., Woldesenbet, A., & Rokooei, S. (2021). Comparison of BIM Adoption Models between Public and Private Sectors through Empirical Investigation. *Advances in Civil Engineering*, *2021*. https://doi.org/10.1155/2021/5577654

Bryan, J. D., & Zuva, T. (2021). A Review on TAM and TOE Framework Progression and How These Models Integrate. *Advances in Science, Technology and Engineering Systems Journal, 6*(3), 137–145. https://doi.org/10.25046/aj060316

Bryde, D., Broquetas, M., & Volm, J. M. (2013). The project benefits of building information modelling (BIM). *International Journal of Project Management*, *31*(7), 971–980. https://doi.org/10.1016/j.ijproman.2012.12.001

Cao, Y., Kamaruzzaman, S. N., & Aziz, N. M. (2022). Building Information Modeling (BIM) Capabilities in the Operation and Maintenance Phase of Green Buildings: A Systematic Review. *Buildings*, *12*(830). https://doi.org/10.3390/buildings12060830

Cavka, H. B., Staub-French, S., & Poirier, E. A. (2017). Developing owner information requirements for BIM-enabled project delivery and asset management. *Automation in Construction*, *83*, 169–183. https://doi.org/10.1016/j.autcon.2017.08.006

Che-Ghani, N. Z., Myeda, N. E., & Ali, A. S. (2016). Operations and Maintenance Cost for Stratified Buildings: A Critical Review. *MATEC Web of Conferences*, *66*. https://doi.org/10.1051/00041

Cheng, B., Li, J., Tam, V. W. Y., Yang, M., & Chen, D. (2020). A BIM-LCA approach for estimating the greenhouse gas emissions of large-scale public buildings: A case study. *Sustainability (Switzerland), 12*(2). https://doi.org/10.3390/su12020685

Cho, J., Cheon, Y., Jun, J. W., & Lee, S. (2022). Digital advertising policy acceptance by out-of-home advertising firms: a combination of TAM and TOE framework. *International Journal of Advertising, 41*(3), 500–518. https://doi.org/10.1080/02650487.2021.1888562

Das, J., Leong, E. L., Leong, C. P. Y., Ng, D., & Ng, K. (2015). A CONSTRUCTION PRODUCTIVITY MAGAZINE : The Second Construction Productivity Roadmap. *BuildSmart*. www.bca.gov.sg

Dixit, M. K., Venkatraj, V., Ostadalimakhmalbaf, M., Pariafsai, F., & Lavy, S. (2019). Integration of facility management and building information modeling (BIM): A review of key issues and challenges. *Facilities, 37*(7–8), 455–483. https://doi.org/10.1108/F-03-2018-0043

Dong, R.R. and Martin, A. (2017). Research on barriers and government driving force in technological innovation of architecture based on BIM. *Eurasia Journal of Mathematics, Science and Technology Education, 13*(8), 5757-5763.

Doumbouya, L., Gao, G., & Guan, C. (2016). Adoption of the Building Information Modeling (BIM) for Construction Project Effectiveness: The Review of BIM Benefits. *American Journal of Civil Engineering and Architecture, 4*(3), 74–79. https://doi.org/10.12691/ajcea-4-3-1

Eadie, R., Browne, M., Odeyinka, H., McKeown, C., & McNiff, S. (2013). BIM implementation throughout the UK construction project lifecycle: An analysis. *Automation in Construction*, *36*, 145–151. https://doi.org/10.1016/j.autcon.2013.09.001

Edirisinghe, R., Kalutara, P. L., & London, K. (2016). An investigation of BIM adoption of owners and facility managers in Australia: Institutional case study. *RMIT Research Repository*. https://researchrepository.rmit.edu.au/discovery/delivery/61RMIT_INST:ResearchRepository/12247170700001341?l#13248403230001341

Gao, X., & Pishdad-Bozorgi, P. (2019). BIM-enabled facilities operation and maintenance: A review. *In Advanced Engineering Informatics 39*, 227–247. https://doi.org/10.1016/j.aei.2019.01.005

GhaffarianHoseini, A., Zhang, T., Nwadigo, O., GhaffarianHoseini, A., Naismith, N., Tookey, J., & Raahemifar, K. (2017). Application of nD BIM Integrated Knowledge-based Building Management System (BIM-IKBMS) for inspecting post-construction energy efficiency. *Renewable and Sustainable Energy Reviews 72*, 935–949. https://doi.org/10.1016/j.rser.2016.12.061

Gholami, Z., Abdekhoda, M., & Gavgani, V. Z. (2018). Determinant factors in adopting mobile technology-based services by academic librarians.

DESIDOC Journal of Library and Information Technology, 38(4), 271–277. https://doi.org/10.14429/djlit.38.4.12676

Hair, J. F., Hult, G. T. M., Ringle, C. M., & Sarstedt, M. (2017). A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM). *SAGE Publications*.

Hair, J. F., Ringle, C. M., Sarstedt, M. (2011): PLS-SEM: Indeed a silver bullet. *Journal of Marketing Rheory and Practice, 19*(2), 139-152.

Harun, A. N., Samad, S. A., Mohd Nawi, N. M., & Haron, N. A. (2016). Existing Practices of Building Information Modeling (BIM) Implementation in the Public Sector. *Int. J Sup. Chain. Mgt*, *5*(4). http://excelingtech.co.uk/

Hoang, G. v., Vu, D. K. T., Le, N. H., & Nguyen, T. P. (2020). Benefits and challenges of BIM implementation for facility management in operation and maintenance face of buildings in Vietnam. *IOP Conference Series: Materials Science and Engineering, 869*(2). https://doi.org/10.1088/1757-899X/869/2/022032

Houache, H., Abd Rahim, H., & Shah, A. (n.d.). Analysis of models for e-commerce adoption factors in developing countries.

Ilter, D., & Ergen, E. (2015). BIM for building refurbishment and maintenance: current status and research directions. *Structural Survey 33*(3), 228–256. https://doi.org/10.1108/SS-02-2015-0008

Imoudu, E. W. (2016). FACTORS AFFECTING BUILDING INFORMATION MODELLING ADOPTION BY MALAYSIAN CONSULTANTS AND CONTRACTORS. *Universiti Teknologi Malaysia Institutional Repository.*

Kamaruzzaman, S. N., Myeda, N. E., Zawawi, E. M. A., & Ramli, R. M. (2018). Developing facilities management (FM) competencies for Malaysia: Reference from international practice. *Journal of Facilities Management, 16*(2), 157–174. https://doi.org/10.1108/JFM-08-2017-0036

Khan, S. R., & Ali, M. (2022). An Overview on Relation Between Energy and Facility Management Models Using BIM Tools. *1st International Conference on Engineering and Applied Natural Sciences*. https://www.researchgate.net/publication/361085363

Kim, S., Park, C.H. & Chin, S. (2016). Assessment of BIM acceptance degree of Korean AEC participants. *KSCE Journal of Civil Engineering*, *20*(4), 1163-1177.

Kline, R. B. (2016). Principles and Practice of Structural Equation Modeling. *New York: The Guilford Press.*

Lai, Y. L., & Lee, J. (2020). Integration of Technology Readiness Index (TRI) Into the Technology Acceptance Model (TAM) for Explaining Behavior in Adoption of BIM. *Asian Education Studies*, *5*(2), 10. https://doi.org/10.20849/aes.v5i2.816

HM Government. (2015). Level 3 Building Information Modelling - Strategic Plan. *Digital Built Britain*.

Memon, A. H., Rahman, I. A., Memon, I., Iffah, N., & Azman, A. (2014). BIM in Malaysian Construction Industry: Status, Advantages, Barriers and Strategies to Enhance the Implementation Level 1. *Research Journal of Applied Sciences, Engineering and Technology*, *8*(5), 606–614.

Memon, M. A., Ramayah, T., Cheah, J.-H., Ting, H., Chuah, F., & Cham, T. H. (2021). PLS-SEM STATISTICAL PROGRAMS: A REVIEW. *Journal of Applied Structural Equation Modeling*, *5*(1), i–xiv. https://doi.org/10.47263/jasem.5(1)06

Mewomo, M. C., Ndlovu, P. M., & Iyiola, C. O. (2022). Factors affecting effective facilities management practices in South Africa: a case study of Kwazulu Natal Province. *Facilities*, *40*(15–16), 107–124. https://doi.org/10.1108/F-09-2021-0087

Miettinen, R., Kerosuo, H., Metsälä, T., & Paavola, S. (2018). Bridging the life cycle: a case study on facility management infrastructures and uses of BIM. *Journal of Facilities Management*, *16*(1), 2–16. https://doi.org/10.1108/JFM-04-2017-0017

Mohd Isa, N., Nizam Kamaruzzaman, S., Mohamed, O., Jaapar, A., & Zaliza Asbollah, A. (2016). Facilities Management Practices in Malaysia: A Literature Review. *MATEC Web of Conferences, 66*. https://doi.org/10.1051/00054

MOHURD. (2016). 2016-2020 Years' Outline of Informatization Development of Construction Industry. *Ministry of Housing and Urban-Rural Development of the People's Republic of China.*

Naghshbandi, S. N. (2016). BIM for Facility Management: Challenges and Research Gaps. *Civil Engineering Journal*, *2*(12). www.CivileJournal.org

Najjar, M. K., Figueiredo, K., Evangelista, A. C. J., Hammad, A. W. A., Tam, V. W. Y., & Haddad, A. (2022). Life cycle assessment methodology integrated with BIM as a decision-making tool at early-stages of building design. *International Journal of Construction Management, 22*(4), 541–555. https://doi.org/10.1080/15623599.2019.1637098

Nassereddine, H., Hatoum, M. B., & Hanna, A. S. (2022). Overview of the State-of-Practice of BIM in the AEC Industry in the United States. *Proceedings of the International Symposium on Automation and Robotics in Construction, 2022-July*, 524–531. https://doi.org/10.22260/isarc2022/0074

National Guidelines for Digital Modelling. (2009). *Cooperative Research Centre for Construction Innovation*.

NATSPEC National BIM Guide (2022). *Construction Information Systems Limited (NATSPEC)*. www.natspec.com.au

Olapade, D. T., & Ekemode, B. G. (2018). Awareness and utilisation of building information modelling (BIM) for facility management (FM) in a developing economy: Experience from Lagos, Nigeria. *Journal of Facilities Management*, *16*(4), 387–395. https://doi.org/10.1108/JFM-09-2017-0046

Olanrewaju, O. I., Kineber, A. F., Chileshe, N., & Edwards, D. J. (2022). Modelling the relationship between Building Information Modelling (BIM) implementation barriers, usage and awareness on building project lifecycle. *Building and Environment*, *207*. https://doi.org/10.1016/j.buildenv.2021.108556

Othman, I., Al-Ashmori, Y. Y., Rahmawati, Y., Mugahed Amran, Y. H., & Al-Bared, M. A. M. (2020). The level of Building Information Modelling (BIM) Implementation in Malaysia. *Ain Shams Engineering Journal*, *12*(1), 455–463. https://doi.org/10.1016/j.asej.2020.04.007

Panuwatwanich, K. and Peansupap, V. (2013) Factors affecting the current diffusion of BIM: a qualitative study of online professional network. *Creative Construction Conference*, 6-9.

Pärn, E. A., Edwards, D. J., & Sing, M. C. P. (2017). The building information modelling trajectory in facilities management: A review. *Automation in Construction*, 75, 45–55. https://doi.org/10.1016/j.autcon.2016.12.003

Pavón, R. M., Alberti, M. G., Álvarez, A. A. A., & Carrasco, I. D. R. C. (2021). Use of bim-fm to transform large conventional public buildings into efficient and smart sustainable buildings. *Energies*, *14*(11). https://doi.org/10.3390/en14113127

Peterson, R. A., & Kim, Y. (2013). On the relationship between coefficient alpha and composite reliability. *Journal of Applied Psychology*, *98*(1), 194–198. https://doi.org/10.1037/a0030767

Pishdad-Bozorgi, P., Gao, X., Eastman, C., & Self, A. P. (2018). Planning and developing facility management-enabled building information model (FM-enabled BIM). *Automation in Construction, 87*, 22–38. https://doi.org/10.1016/j.autcon.2017.12.004

Prihatono, F. A., & Adi, T. J. W. (2020). Building Information Modeling (BIM) Technology Acceptance Analysis Using Technology Acceptance Model (TAM). *IPTEK Journal of Proceedings Series, 1.*

Puķite, I., & Geipele, I. (2017). Different Approaches to Building Management and Maintenance Meaning Explanation. *Procedia Engineering*, *172*, 905–912. https://doi.org/10.1016/j.proeng.2017.02.099

Qin, X., Shi, Y., Lyu, K., & Mo, Y. (2020). Using a tam-toe model to explore factors of building information modelling (Bim) adoption in the construction industry. *Journal of Civil Engineering and Management*, *26*(3), 259–277. https://doi.org/10.3846/jcem.2020.12176

Rahim, N. S. A., Ismail, S., Habib, S. N. H. A., & Chofreh, A. G. (2022). IMPLEMENTATION STRATEGIES OF BUILDING INFORMATION MODELLING TOWARDS SUSTAINABLE AFFORDABLE HOUSING INITIATIVES IN MALAYSIA. *9th International Graduate Conference on Engineering, Science and Humanities.* https://sps.utm.my/

Rahim, R. (2022). Building Sector Needs Diversity. *The Star.* Retrieved December 5, 2022, from https://www.thestar.com.my/news/nation/2022/06/09/building-sector-needs-diversity

Rogers, E. M. (2003) Diffusion of Innovations, Fifth Edition. *New York Free Press.*

Seed, L. (2015), The dynamics of BIM adoption: a mixed methods study of BIM as an innovation within the United Kingdom Construction Industry. *Doctoral dissertation*, University of Huddersfield.

Shen, L., Edirisinghe, R., & Goh, Y. M. (2016). An Investigation of BIM Readiness of Owners and Facility Managers in Singapore: Institutional Case Study. https://www.researchgate.net/publication/303840849

Sima Yusoff, S. N., Brahim, J., & Mat Yusoff, Z. (2021). Incorporation of Building Information Modelling (BIM) in Malaysian Higher Education Institutions: A Review. *Built Environment Journal*, *18*(1), 15–22.

Sinenko, S., Hanitsch, P., Aliev, S., & Volovik, M. (2020). The implementation of BIM in construction projects. *E3S Web of Conferences*, *164*. https://doi.org/10.1051/e3sconf/202016408002

Smith, K. A. (2002). Teamwork and Project Management. *McGraw-Hill's BEST Series*.

Songer, A. D., Young, R., & Davis, K. (2001). SOCIAL ARCHITECTURE FOR SUSTAINABLE IT IMPLEMENTATION IN AEC/EPC. *Construction Informatics Digital Library*. http://itc.scix.net/

Stride, M., Hon, C. K. H., Liu, R., & Xia, B. (2020). The use of building information modelling by quantity surveyors in facilities management roles. *Engineering, Construction and Architectural Management*, *27*(8), 1795–1812. https://doi.org/10.1108/ECAM-11-2019-0660

Stromnes, S. (2022). BIM implementation and adoption in the Architecture, Engineering and Construction industry.

Tan, A. Z. T., Zaman, A., & Sutrisna, M. (2018). Enabling an effective knowledge and information flow between the phases of building construction and facilities management. *Facilities*, *36*(3–4), 151–170. https://doi.org/10.1108/F-03-2016-0028

Toan, N. Q., Tam, N. V., Diep, T. N., & Anh, P. X. (2022). ADOPTION OF BUILDING INFORMATION MODELING IN THE CONSTRUCTION PROJECT LIFE CYCLE: BENEFITS FOR STAKEHOLDERS. *Architecture and Engineering*, *7*(1), 56–71. https://doi.org/10.23968/2500-0055-2022-7-1-56-71

Tornatzky L.G., Fleischer M., & Chakrabarti A.K. (1990). The processes of technological innovation. *Lexington Books.*

Tripopsakul, S. (2018). Social media adoption as a business platform: An integrated tam-toe framework. *Polish Journal of Management Studies*, *18*(2), 350–362. https://doi.org/10.17512/pjms.2018.18.2.28

Underwood, J., & Isikdag, U. (2011). Emerging technologies for BIM 2.0. *Construction Innovation*, *11*(3), 252–258. https://doi.org/10.1108/14714171111148990

Van Tam, N., Diep, T. N., Quoc Toan, N., & le Dinh Quy, N. (2021). Factors affecting adoption of building information modeling in construction projects: A case of Vietnam. *Cogent Business and Management*, *8*(1). https://doi.org/10.1080/23311975.2021.1918848

Volk, R., Stengel, J., & Schultmann, F. (2014). Building Information Modeling (BIM) for existing buildings - Literature review and future needs. *Automation in Construction*, *38*, 109–127. https://doi.org/10.1016/j.autcon.2013.10.023

Wan Mohammad, W. N. S., Abdullah, M. R., Ismail, S., & Takim, R. (2018). Overview of Building Information Modelling (BIM) adoption factors for construction organisations. *IOP Conference Series: Earth and Environmental Science*, *140*(1). https://doi.org/10.1088/1755-1315/140/1/012107

Wang, G., Liu, Z. and Wang, H. (2016). Key factors affecting BIM adoption is China based on TOE&RC. *International Conference on Mechanics, Materials and Structural Engineering (ICMMSE 2016)*, 237-242.

Wang, Y., Wang, X., Wang, J., Yung, P., & Jun, G. (2013). Engagement of facilities management in design stage through BIM: Framework and a case study. *Advances in Civil Engineering*. https://doi.org/10.1155/2013/189105

Wijekoon, C., Manewa, A., & Ross, A. D. (2020). Enhancing the value of facilities information management (FIM) through BIM integration. Engineering, *Construction and Architectural Management*, *27*(4), 809–824. https://doi.org/10.1108/ECAM-02-2016-0041

Wu, Z., Jiang, M., Li, H., Luo, X., & Li, X. (2021). Investigating the critical factors of professionals' BIM adoption behavior based on the theory of planned behavior. *International Journal of Environmental Research and Public Health*, *18*(6), 1–19. https://doi.org/10.3390/ijerph18063022

Xu, H., Feng, J. and Li, S. (2014). Users-orientated evaluation of building information model in the chinese construction industry. *Automation in Construction, 39*, 32-46. doi: 10.1016/j.autcon.2013.12.004.

Yalcinkaya, M., & Singh, V. (2014). Building Information Modeling (BIM) for Facilities Management-Literature Review and Future Needs. https://doi.org/10.13140/RG.2.1.3052.5525

Yusnida, A. E., Emma, M. N., & Maimunah, S. (2022). FACTORS AFFECTING THE ADOPTION OF BIM-FM INTEGRATION AT THE EARLY PHASE OF THE BIM PROJECT. *9th International Graduate Conference on Engineering, Science and Humanities*. https://sps.utm.my/

Yusof, A., & Shah, A. (2017, November 21). Compulsory BIM For Public Projects Above RM100m. *New Straits Times*. Retrieved October 31, 2021, from https://www.pressreader.com/malaysia/new-straits-times/20171121/282295320501561

Zaliza Asbollah, A., Mohd Isa, N., & Nizam Kamaruzzaman, S. (2016). Sustainability and the facilities management in Malaysia. *MATEC Web of Conferences*, *66*. https://doi.org/10.1051/00085

Zhao, Y., Sun, Y., Zhou, Q., Cui, C., & Liu, Y. (2022). How A/E/C professionals accept BIM technologies in China: a technology acceptance model perspective. *Engineering, Construction and Architectural Management.* https://doi.org/10.1108/ECAM-04-2022-0308

APPENDIX A

PERCEPTION ON THE IMPLEMENTATION OF BUILDING INFORMATION MODELLING (BIM) IN FACILITY MANAGEMENT (FM)

Dear Respondents,

I am Ng Ching Woon, a final year student pursuing Master of Business Administration (Building Management) in Universiti Tunku Abdul Rahman (UTAR). I am currently conducting a research project with the topic of "Perception on the implementation of Building Information Modelling (BIM) in Facility Management (FM)".

You are invited to participate in this research by filling up this questionnaire. This questionnaire aims to investigate the level of acceptance of BIM application in FM industry in Malaysia. Meanwhile, we are also looking forward to understand the benefits of BIM in the view point of FM practitioners.

Your cooperation and honest response to complete this questionnaire is highly appreciated. Your response will be kept confidential, and only the statistics report extracted from the all questionnaires collected will be disclosed.

For any suggestions or inquires related to this survey, please contact Ng Ching Woon at ngcw96@1utar.my or +6012-9801663. Thank you.

PERSONAL DATA PROTECTION STATEMENT

Please be informed that in accordance with Personal Data Protection Act 2010 ("PDPA") which came into force on 15 November 2013, Universiti Tunku Abdul Rahman ("UTAR") is hereby bound to make notice and require consent in relation to collection, recording, storage, usage and retention of personal information.

Notice:

1. The purposes for which your personal data may be used are inclusive but not limited to:

- For assessment of any application to UTAR
- For processing any benefits and services
- For communication purposes
- For advertorial and news
- For general administration and record purposes
- For enhancing the value of education
- For educational and related purposes consequential to UTAR
- For the purpose of our corporate governance
- For consideration as a guarantor for UTAR staff/ student applying for his/her scholarship/ study loan

2. Your personal data may be transferred and/or disclosed to third party and/or UTAR collaborative partners including but not limited to the respective and appointed outsourcing agents for purpose of fulfilling our obligations to you in respect of the purposes and all such other purposes that are related to the purposes and also in providing integrated services, maintaining and storing records. Your data may be shared when required by laws and when disclosure is necessary to comply with applicable laws.

3. Any personal information retained by UTAR shall be destroyed and/or deleted in accordance with our retention policy applicable for us in the event such information is no longer required.

4. UTAR is committed in ensuring the confidentiality, protection, security and accuracy of your personal information made available to us and it has been our ongoing strict policy to ensure that your personal information is accurate, complete, not misleading and updated. UTAR would also ensure that your personal data shall not be used for political and commercial purposes.

Consent:

1. By submitting this form you hereby authorise and consent to us processing (including disclosing) your personal data and any updates of your information, for the purposes and/or for any other purposes related to the purpose.

2. If you do not consent or subsequently withdraw your consent to the processing and disclosure of your personal data, UTAR will not be able to fulfil our obligations or to contact you or to assist you in respect of the purposes and/or for any other purposes related to the purpose.

3. You may access and update your personal data by writing to us at ngcw96@1utar.my.

Acknowledgement of Notice

- ☐ Yes - I have been notified by you and that I hereby understood, consented and agreed per UTAR above notice.
- ☐ No - I disagree, my personal data will not be processed.

Section 1: Demographic of Respondent
Gender: ☐ Male ☐ Female
Age: ☐ Below 20 years old ☐ 20 - 29 years old ☐ 30 - 39 years old ☐ 40 - 49 years old ☐ 50 - 59 years old ☐ Above 60 years old
Race: ☐ Malay ☐ Chinese ☐ Indian ☐ Other
What is your educational level? ☐ Primary School ☐ Secondary School ☐ Diploma ☐ Bachelor ☐ Postgraduate or higher ☐ Other
Are you working in Malaysia? ☐ Yes

☐ No

☐ Maybe

How long is your working experience?

☐ No experience

☐ 1 - 5 years

☐ 6 - 10 years

☐ 11 - 15 years

☐ 16 - 20 years and above

☐ 21 years and above

What is your profession?

☐ Architecture

☐ Property Development

☐ Engineering

☐ Construction

☐ Building / Facilities Management

☐ Building Material Supply

☐ BIM Modelling

☐ Quantity Surveying

☐ Research

☐ Other

Section 2: BIM Adoption in Company

Introduction of BIM

Building Information Modelling (BIM) is a one-stop management system to create information rich 3D models and act as a central database for stakeholders to create, access, and communicate the project information both graphically and also in spreadsheet formats throughout the entire project life cycle.

The 3D digital model representation helps stakeholders to visualize the physical and functional characteristics of buildings for instance the data of floor spaces, building systems, material details and consumption characteristics. These information helps with operations and maintenance tasks as well as project planning and resource allocation.
Is your company using BIM when conducting their projects? ☐ Yes ☐ No ☐ Maybe
Is your company planning to use BIM? ☐ Yes ☐ No ☐ Maybe
Is there one or more persons in your company interested in BIM? ☐ Yes ☐ No ☐ Maybe
At what BIM level is your company conducting their projects? ☐ 3D ☐ 4D (3D + Construction Process Scheduling) ☐ 5D (4D + Cost Analysis) ☐ 6D (5D + Energy Consumption Monitoring) ☐ 7D (6D + Lifecycle Performance Assessment)

☐ None of above
What is the average cost of the projects you involved? ☐ Below RM1 million ☐ RM1 million - RM10 million ☐ RM10 million - RM100 million ☐ RM100 million - RM1 billion ☐ Above RM1 billion

Section 3: Perceived ease of use of BIM in Facilities Management (FM).					
Please indicate how strongly you agree or disagree with the statements below by choosing from 1 to 5 which represents: 1 – Strongly Disagree 2 – Disagree 3 – Neither 4 – Agree 5 – Strongly Agree	**1**	**2**	**3**	**4**	**5**
I think learning to use BIM in FM is easy.					
I think the input of FM related information to BIM is easy.					
I think update of FM related information in BIM is easy.					
I think finding the information i need with BIM in FM is easy.					
I think becoming skillful at using BIM in FM is easy.					
I think all the accessible information regarding to BIM in FM are clear and understandable.					
I think it is easy for me to complete FM tasks with the aid of BIM.					

Overall, i find the use of BIM in FM is easy.					
Section 4: Perceived usefulness of BIM in Facilities Management (FM).					
Please indicate how strongly you agree or disagree with the statements below by choosing from 1 to 5 which represents: 1 – Strongly Disagree 2 – Disagree 3 – Neither 4 – Agree 5 – Strongly Agree	**1**	**2**	**3**	**4**	**5**
Implementation of BIM in FM would be helpful in enhance collaboration between stakeholders.					
Implementation of BIM in FM would be resulted in the increased knowledge sharing and collaborative working.					
Implementation of BIM in FM would be helpful in maintain success interoperability of building components throughout the building cycle.					
Implementation of BIM in FM would be helpful in allow diversity management.					
Implementation of BIM in FM would be helpful in facilitate energy efficiency analysis.					
Implementation of BIM in FM would be resulted in an overall improvement of work efficiency.					
Implementation of BIM in FM would be resulted in increased clarity in presenting an idea.					
Implementation of BIM in FM would be resulted in increased effectiveness in illustrating thinking.					
Implementation of BIM in FM would be resulted in better performance in retrieving information.					

Implementation of BIM in FM would be resulted in easier communication with others.					
Implementation of BIM in FM would be helpful in building system evaluation.					
Implementation of BIM in FM would be helpful in achieving sustainable goal.					
Implementation of BIM in FM would be resulted in an overall improvement of productivity.					
Overall, i find BIM is useful in FM.					
Section 5: Economic factor					
Please indicate how strongly you agree or disagree with the statements below by choosing from 1 to 5 which represents: 1 – Strongly Disagree 2 – Disagree 3 – Neither 4 – Agree 5 – Strongly Agree	**1**	**2**	**3**	**4**	**5**
I feel implementing BIM requires huge capital outlays.					
I feel implementation of BIM in FM can help to save the operation and maintenance cost.					
I feel the return on investment of implementing BIM in FM can cover up the cost of implementation in long run.					
I feel there is an absence of understanding of BIM implication by finance management professionals.					
Section 6: Technological factor					

Please indicate how strongly you agree or disagree with the statements below by choosing from 1 to 5 which represents: 1 – Strongly Disagree 2 – Disagree 3 – Neither 4 – Agree 5 – Strongly Agree	**1**	**2**	**3**	**4**	**5**
I feel the speed of BIM tools is sufficient.					
I feel the technology quality of BIM tools is good.					
I feel the IT support for BIM tools is good.					
I like the functionality / practicality of BIM tools.					
I like the result demonstrability of BIM tools.					
I think the implementation of BIM tools in FM is feasible.					
Section 7: Environmental factor					
Please indicate how strongly you agree or disagree with the statements below by choosing from 1 to 5 which represents: 1 – Strongly Disagree 2 – Disagree 3 – Neither 4 – Agree 5 – Strongly Agree	**1**	**2**	**3**	**4**	**5**
BIM in FM is under requirement of national policies.					
There is a standard framework of BIM in FM established by authority as a model or criterion.					
Stakeholders intend to collaborate in the optimum utilization of BIM model in FM.					
Implementing BIM in FM is popular in my industry.					

Implementing BIM in FM helps my organization to gain competitive advantage compare to other companies.					
Government is supportive to BIM implementation in FM.					
There is government incentives to support BIM in FM.					
There are many BIM in FM providers in my country.					
There are a lots of accessible guidance, instruction, training and information about BIM software in FM.					
I think it is easy to find case study as a precedent to demonstrate BIM benefits in FM.					
Section 8: Organizational factor					
Please indicate how strongly you agree or disagree with the statements below by choosing from 1 to 5 which represents: 1 – Strongly Disagree 2 – Disagree 3 – Neither 4 – Agree 5 – Strongly Agree	**1**	**2**	**3**	**4**	**5**
I feel my organization is ready to implement BIM in FM.					
I feel my oganization is willing to implement BIM in FM.					
My organization is having the necessary technical infrastructure to implement BIM in FM.					
My organization is having the capacity to implement BIM in FM.					

I feel the implementation of BIM in FM will benefits my organization.					
I feel my organization is financially affordable to implement BIM in FM.					
I feel my organization is having adequate expertise to implement BIM in FM.					
Implementation of BIM in FM is risky to my organization.					
Section 9: Intension to use BIM in Facilities Management (FM).					
Please indicate how strongly you agree or disagree with the statements below by choosing from 1 to 5 which represents: 1 – Strongly Disagree 2 – Disagree 3 – Neither 4 – Agree 5 – Strongly Agree	**1**	**2**	**3**	**4**	**5**
Adoption of BIM in FM is a wise idea.					
The adoption of BIM in FM is compatible with the operations in my workplace.					
The adoption of BIM in FM fitted well with the way if i want to do things in FM.					
The adoption of BIM in FM would fulfill my needs.					
Assuming I had access to BIM, I intend to use it in FM.					
In future, I intend to adopt FM-enabled BIM into my workspace.					