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Perspective towards the Perceived Benefits and Challenges on Building Information Modelling - Facility Management (BIM-FM) Integration at an Early Stage of BIM Projects

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Abstract

Building information modelling (BIM) is the most recent facility management (FM) technology adopted in Malaysia. However, management and information technology (IT) system improvements are required for the adoption of this technology. Incorporating BIM and FM at an early stage of a project has the potential to yield significant benefits but may also increase project risk. Through a survey, this study aims at investigating the prospective benefits and challenges of BIM-FM integration in the early phases of a BIM project. 109 (55.6%) of the 196 facility management companies in Klang Valley answered a questionnaire survey that was sent to them. To determine the perceived benefits and obstacles of the integrated BIM-FM process, mean scores and standard deviations were computed. As a result, respondents perceived positively that integrating BIM-FM in the early phase of the BIM project will increase performance, improve collaboration and communication, increase FM business values, and reduce costs and time. In the meantime, all respondents agreed that organizational, process and technological factors influence the early adoption of BIM-FM integration in the Malaysian construction industry. This study substantially contributes to the current understanding of the advantages and disadvantages of BIM-FM integration in the early stages of BIM projects in Malaysia.

Keywords: BIM-FM integration, early phase, perceived benefit, challenges

1.0 INTRODUCTION

The evolution of the 4.0 revolution in the construction business has introduced an additional dimension of information communication and technology (ICT) to the facilities management (FM) industry. Leveraging the ICT for Malaysian FM is the approach to respond to the new environmental challenges. The architecture, engineering, construction/facilities management industry has seen a trend towards building information modelling (BIM), a process for modelling building information. BIM is a three-dimensional, real-time, and dynamic building modelling software utilised by design and engineering teams to generate a building information model comprising geometry, spatial relationships, geographic data, and the quantities and qualities of building components, which can be employed in the construction industry.

BIM for facilities management (FM) is still a relatively new phenomenon. Thus, designing, building, and managing the facilities used in the built environment required a holistic approach. Therefore, a comprehensive approach is required to construct and manage the built environment's facilities. The development of a building asset required vast quantities of information, most of which is essential to FM operations and software. If data could be incorporated into this model, end users may not need a separate asset management system, since they would have access to all the data, they need to operate the facility in a single database. Aldowayan et al. (2020) and Liu and Issa (2014) endorse this viewpoint, which describes BIM as a centralised platform that enables the integration of its variations into a single model.

The adoption of BIM in the early stages of a project is more helpful for the FM than the design and construction phase. Aldowayan et al. (2020) noted that BIM had greater value in maintenance activities (Ilter & Ergen, 2015). It can boost the efficient management of FM with accurate information for the built environment (Nicał & Wodyński, 2016). Facility managers also view BIM as a system that allows access and retrieval of life cycle data collected for FM employment. When they choose to adopt BIM, the data and information must be comprehensive, current, and appropriate for the needs of the FM team. It is expected that the information is captured, updated, and used across the entire phases of a project life cycle.

However, most people in the FM industry still could not recognize and quantify what benefits BIM brings into FM practice. Lack of knowledge and awareness is a factor that impedes the adoption of BIM in FM. This is supported by Kong and Ho (2022) who discovered that unfamiliarity and failure to understand and comply with the BIM standard ISO 19650 as factors that leashed the low adoption level of BIM in the Malaysian industry. Other than that, BIM is still used limitedly in operations and maintenance because FM organisations are reluctant to invest in BIM technology. There are insufficient BIM experts and the absence of a strategic approach for BIM utilisation in FM was also stated as a factor that restricted the usage of BIM technology in FM.

Although BIM has been implemented in the design and construction phases, its use in FM remains limited. To facilitate BIM deployment during the operation and maintenance (O&M) phase, it is necessary to integrate facilities management (FM) into the BIM process early in the BIM project. For these reasons, this study analyses the perceived benefits and limitations of BIM-FM integration in the Malaysian context at an early stage of the BIM project. This study aims to bridge the gap between knowledge and practice by identifying and assessing the perceived benefits and obstacles to the operation and maintenance (O&M) phase when BIM-FM is introduced early in the BIM project. The study considers the benefits and challenges from various viewpoints of the FM industry and those from diverse organizations, such as FM consultants, FM contractors, property managers and developers.

2.0 LITERATURE REVIEW

2.1 BIM-FM Integration

Facilities management entails an expansive field that incorporates multidisciplinary and independent disciplines, all of which have the aim of maximizing building functions while preserving occupants' well-being (Becerik-Gerber et al., 2012). FM provides a wide range of services, including both technical and non-technical. The goal is to guarantee the quality of life of the people living/working in the built environment and to fulfil the core business goals by conforming to ISO 41011:2017. In the Malaysian context, facility managers (FMs) focus mainly on the management and maintenance of facilities and services. The role of FM in an organisation is to integrate different services process across the organisation and deliver to the strategic objectives of the organisation to improve productivity and effectiveness of the primary business. The current FM practices involve the use of electronics and information technology to automate their operational and maintenance procedures. To make the most of information communication and technology (ICT) in FM, appropriate FM software is needed to unite all the applicable information with the systems allowed for the management and operations of a facility. To guarantee the smooth operation of the facility, it is imperative to have unified access to manage all activities and information.

ICT uses in FM are diverse and cover various services and information related to the FM. Nowadays, the information of FM is organised and maintained in a dispersed information system such as Computer Aided Facility Management (CAFM), Computerised Maintenance and Management System (CMMS) and Building Automation System. The Building Management System (BMS) also should tightly integrate with FM software so that the operation of building systems is also possible through the FM interface. The information and data required for such systems come from different sources, are created and manipulated several times during the assets life cycle, and are usually not synchronised between systems, resulting in error-prone processes (Becerik-Gerber et al., 2012). In a traditional approach, once the construction is completed, the prime contractor will deliver all the asset information to the client. According to Teicholz (2013), all the information about the building is stored and never been or rarely maintained across the building life cycle. However, if the information is not stored properly, the cost of finding it becomes so expensive. This means it would be easier and cheaper to replace the information than to sort through the original documents (Tsay et al., 2022). Other than that, the conventional process also requires the information to be manually entered, which is inadequate, ineffective, and expensive.

Marmo et al. (2019) stated that BIM technology provides a conducive environment for information exchange among FM practitioners. According to Durdyev et al. (2022), BIM has been widely implemented worldwide in the architectural, engineering, construction, and operations industries. Although BIM is on the rise in Malaysia, little study has been conducted on BIM adoption in the country, especially on BIM-FM integration. According to reports, there are several potential benefits to utilising BIM in the FM context. As potential major stakeholders in building information modelling (BIM) projects, facilities managers (FMs) must have a thorough understanding of the BIM process and the value BIM data can provide during the operational phase. Gao and Pishdad-Bozorgi (2019) have identified and compiled a list of approximately twenty-five (25) FM tasks BIM could digitise. By incorporating BIM-FM into the design and construction process, it is proposed to collect asset information in order to utilise the model-generated data. The information flow in a BIM-FM information delivery process may not be utilised during operations, but as part of a process to develop and communicate structured asset information of the building to its owners for use during the facility's entire life.

To make the deployment of BIM in the FM phase more efficient, project requirements must be managed in line with BIM ISO 19650. The ISO 19650 standard is an international standard for handling information across the entire life cycle of a constructed asset using building information modelling (BIM). It comprises five parts and defines the concepts and principles for information management at each maturity level of BIM. It is a collaborative procedure for the proper management of information throughout the delivery and operation phase of assets. ISO 19650 was developed to assure compliance with quality requirements for digital processes and information management during the design, construction, and management of an asset. The ISO 19650 series enables teams to reduce unnecessary operations and improve the predictability of costs and timelines associated with the execution of works. This is accomplished through a standard approach to information management and adherence to the BIM method's key principles. Part 2 of the series focuses on the delivery phase of assets and explains the strategy, management of information, and information flows within project teams. It is created as a comprehensive process flow, outlining all points and stages in the contract's articulation. The purpose is to provide a collection of suggestions for all parties involved in the management of an asset.

Implementing BIM in FM areas brings many potential benefits to FM operations. Aziz et al. (2016a) explains that within the facilities management realm, BIM is a collection of digital document tools that are stored in a database and can be managed by the owners in real time over the entire life cycle. BIM-enabled FM is increasingly sought on projects (Wijekoon et al., 2020), showing a fundamental change in the AEC industry (Aziz et al., 2016b). ARCHIBUS is a well-known FM software application. The ARCHIBUS develops to integrate workplace management for real estate, infrastructure, and facilities management to specify the requirements of tasks and departments. ARCHIBUS can communicate with Microsoft Office, AutoCAD, and BIM applications like Revit to link with ARCHIBUS for FM based on graphical data and geometric models. Hence, facility managers may access and manage information about their facilities, process data, and visualise components. As a result, it could improve FM practises, such as real-time data access to facilities, examining maintainability, generating and upgrading assets, organising space, planning and emergency, and monitoring and regulating energy.

From an academic perspective, incorporating BIM into FM causes information to be generated and amassed throughout the full lifespan of a facility, from the initial stages of the project through to the renovation stage, to enhance the functioning of the building management. In other words, implementing BIM technology in the FM practice can reduce inaccuracy and incomplete information. With efficient information management provided by BIM, it will support the alteration phase, improve collaborations, enhance the handover and commissioning of the building, expand the decision-making process, and increase return on investment (Aziz et al., 2016a; Pärn et al., 2017). Also, it saves the workforce, money, and time to enter data into the FM tools (Mohanta & Das, 2016). According to Shen et al. (2016), facility managers are likely the second largest beneficiaries of the BIM systems after clients. Other researchers noted that facility managers' actual adoption of BIM systems might experience limited benefits compared to perceived advantages, as Edirisinghe et al. (2016) and Ashworth and Tucker (2017) highlighted.

Yet, due to a lack of expertise in its execution, BIM use in FM remains limited. Considering the value-added, potentials, and constraints of BIM in FM is critical to ensuring the effective integration of BIM and FM throughout the early stages of the BIM project, FM organization may not be in a position to integrate BIM-FM until they have a better understanding of BIM and its benefits. According to Ashworth et al. (2016), most FM practitioners have heard of BIM and believe that it will have a big impact on the FM industry. This survey also reveals that the FM industry is unclear about what BIM should be, and questions what FM professionals must do to enable the successful adoption of BIM. McGraw Hill Construction (2014) reported that global BIM utilization had increased significantly by 2020. In 2011, 43% of respondents had never heard of BIM, but today, awareness is widespread with 73% adopting BIM. This rapid adoption rate reveals that BIM has shown potential; hence, Malaysian organisations must determine justifiable methods and reasons for adopting and diffusing BIM in FM.

Although the opportunities for BIM-FM integration are widely recognized on a global scale, the adoption of BIM in Malaysia's construction industry has been slow because its potential value has not yet been revealed. As highlighted by Hilal et al. (2019), there is a dearth of research into integrating BIM with FM. For a smoother transition of the integration, there is a need for FM experts to notice the fundamental challenges in BIM-FM integration, which might be because of existing work procedures and management structures or technology. They saw that the stated factors were considered barriers to a more extensive implementation. In terms of administrative issues, Terreno et al. (2019) discovered that the top-down approach of managerial strategies has dramatically influenced BIM-FM development and the sustainability of a BIM project. The early integration of BIM-FM will encourage the integration of all project stakeholders' roles, increase business structures, enhance the collaborative process, and optimise productivity throughout all phases of a project's life cycle. Although the goal of BIM is to enhance FM, organisations are still reluctant to involve facility managers during the early planning and design stages because of the lack of perceived benefits. Research also revealed that although BIM-FM adoption offers practical help for FM in the industry, its adoption can be chaotic if the potential advantages of BIM in FM are not well communicated. In addition, it is challenging to change FM practices in the industry to be involved during the early stage of a building's life cycle. This occurs because stakeholders prefer to continue with the conventional process instead of incorporating a new method to improve the current organisation's business strategy.

2.2 Benefits of BIM-FM Integration

BIM technology provides several benefits in various areas for FM. The participation of FM in BIM at an earlier stage will have an impact on the project outcomes, particularly on building performance. Some benefits of BIM integration with FM include the automated process, where integration between BIM-FM offers an opportunity for data transfer and updates through the 6D BIM model. The integration process will provide rapid and efficient access to information on all facility components to offer precise data and improve maintenance practices.

It has been stated that BIM-FM enables the integration of a massive amount of graphical and non-graphical data in data management and libraries. These data need to be communicated and interpreted using a powerful application for information exchange. For the operation and maintenance stage, the non-graphical data should override the graphical data to allow the information to be entered into the FM system. Thus, integrating data from both systems will enhance data management capability later on.

Using the BIM model allows visualisation of the location of the equipment and provides relevant data, thus saving time to retrieve the information. The BIM model delivers the facility manager with a trustworthy approach to observing space and allowing them to perform analysis. The current practice for space management is using Computer-Aided Design (CAD) files and is also supported by CAFM and CMMS. Hence, utilising BIM technology provides the possibility to visualise the area, comprehend underutilised spaces and required space requirements, and track assets throughout multiple moves. Aside from that, BIM technology is also used to automate a preventive maintenance programme by connecting to the existing software and delivering the necessary data.

In addition, BIM-FM integration enables BIM to facilitate the analysis of buildings, particularly in sustainability initiatives that aim to minimise environmental impacts and operational expenses by a large margin. As seen by Bolshakov et al. (2023), BIM has more potential to be implemented in the operation and maintenance (O&M) phase because by applying BIM in operation will reduce operational expenditure and enhance collaboration and communication among the stakeholders. Marmo et al. (2019) further emphasised that BIM-FM integration can improve indoor environmental quality and is capable of managing operation activities more efficiently.

2.3 Challenges of BIM-FM Integration

Notwithstanding the wide range of benefits given by BIM technology, the literature identifies obstacles that prevent BIM from being applied into FM. Moreover, FM's value for the built environment varies. Nowadays, the construction industry must undergo a cultural shift to adopt FM as an integral component of the process. Hence, the absence of facility managers in the early phases of a building's lifecycle is the most significant impediment to BIM adoption. As a result, facility managers are unable to define the necessary information throughout the decision-making phase to enable sustainable maintenance and operation (Al-Kasasbeh et al., 2021). Despite participating in the earliest phases of the project, research reveals that they are not seen as valuable participants. In addition, the lack of BIM expertise among facility managers is also an obstacle to BIM implementation.

The facility life cycle encloses different stages: inception and planning, design, construction, handover and commissioning, operation and maintenance. Likewise, BIM data requirements can be varied for different operation and maintenance practitioners working on different types of facilities. Thus, the flow of information between these levels is horizontal and sequential. It is crucial to control this information's accuracy, suitability, and quality, especially for effective decision-making throughout the operation and maintenance (O&M) phase. Thus, one of the toughest roles of owners upon project handover is to evaluate the information quality (IQ) of the BIM model for facility management. Unfortunately, most of BIM's data are prepared during the design and construction phases, bringing various quality problems, such as erroneous, incomplete, or superfluous data. Patacas et al. (2020) discovered a variety of gaps within the BIM for the FM practice, including the absence of a framework that clarifies the whole BIM for FM workflow; the regularities method to check the compliances of BIM for FM areas is limited; the use of open standards for the data sources required for the operational phase is restricted; and the absence of a CDE that can reaffirm and construct the designated structured (i.e. graphical and non-graphical) and unstructured (i.e. documents) data.

Issues around interoperability and data exchange due to the limited compatibility between BIM and FM technologies are extensively discussed by different studies (Pärn et al., 2017; Yalcinkaya & Singh, 2019). Jang and Collinge (2020) stated that challenges in interoperability and ambiguous definitions of requirements have been identified as the primary factors slowing the widespread adoption of BIM for FM. Other than that, the data exchange between emerging BIM systems and existing building systems is challenging because of the difference between the current capture lifecycle of BIM and FM technologies. Given the disparity in the capture lifecycles of BIM and FM, technologies are crucial, and CAFM and other asset management systems are required for common data libraries and open systems. Thus, 'Construction Operations Building information exchange' (COBie) has been introduced and described as the major type of data interchange. However, it is only sometimes employed. Existing studies indicate that handling data in a COBie format involves a tremendous amount of work. In practice, COBie will export the 3D BIM data to a spreadsheet format before transferring it to the FM system. However, the spreadsheet data requires to be keyed manually into the FM systems. In addition, the COBie needs more information regarding what information will be supplied, when, and by whom.

Even though BIM technology has advanced to a global acclaim level, many aspects of BIM for FM continue to pose challenges for BIM-FM implementation. These include issues with software interoperability, supply chain BIM awareness, contractual barriers and organisational communication issues (Jang & Collinge, 2020). They struggle with the requirement for increased collaboration and better communication amongst key stakeholders in the early project phases. The need for greater collaboration and more communication between key stakeholders at early project stages becomes vital for the facility management to ensure the functionality of the building remains effective throughout the building life cycle.

3.0 METHODOLOGY

3.1 Research Methodology

The method used in this study is based on the quantitative method. The research design for this study is survey research. For early integration of "BIM-FM at the early phase of the BIM process", a questionnaire survey is used to assemble a wide range of views from 'general FM industry' organizations on the current extent of BIM utilisation in FM. As argued by Ang et al. (2020), a questionnaire is a medium to get the required data from a large group of people. This survey aims to gain insight into the current extent of the perceived benefits and the challenges of BIM to be integrated into FM in the early phase by the FM organisation in Malaysia, especially in Klang Valley.

This survey aims to collect information to investigate, generalise, and make inferences from the populations regarding the benefits and challenges of BIM-FM integration. There are five sections in the questionnaire. The first part of the questionnaire was employed to get information about the respondents' profiles. The other parts should elicit information on BIM-FM awareness levels, potential benefits of BIM and FM integration in the early stages of a BIM project, and obstacles to BIM-FM integration. However, this study focuses merely on the advantages and challenges sections. The questions require the respondents to rate their agreement, perception, and attitudes towards the statements using a five-point Likert scale.

The empirical datasets used for this study were derived from survey responses, so descriptive research is used (Karimian et al., 2019). Descriptive survey research is allowed when the questionnaire serves as the research instrument, and the research data are measured on an ordinal scale (Fellows & Liu, 2015). The questions require respondents to rate their agreement, perception, and attitude towards the statements using a five-point Likert scale. The empirical datasets comprised Likert scale evaluations for responses regarding the relative influence of stated advantages and disadvantages of BIM-FM integration (5 = strongly agree, 4 = agree, 3 = somewhat agree, 2 = disagree, and 1 = severely disagree).

3.2 Data and Methods

In this study, a quantitative method was applied. Purposive sampling was utilised, selecting samples based on population knowledge and research objectives. Seven hundred eighty (780) facility management organisations registered with the Construction Industry Development Board (CIDB) in 2020 are the target population for this study. The sample unit for this study is a facility management organisation representing the Malaysian construction industry. A questionnaire survey was given to facility management organisations registered with CIDB under category F, which specialised in the execution of works for general building and infrastructure facilities (F01) and healthcare facilities (F02).

Most of these registered facility management organisations are still involved in the business of facility management. According to Krejcie and Morgan (1970), based on the total population of 500 registered facility management organisations in the study area, the suitable sample size for this study is 217. Yet, data collection was hindered by the COVID-19 epidemic and the execution of the Movement Control Order (MCO) 2.0 set by the Malaysian government, which began in January and continued until May 2021. Roscoe (1975) and Gay and Diehl (1992) noted that the minimum number of participants considered acceptable for research varies depending on the research conducted; 10% of the population is regarded as the minimum for a descriptive study, while 30% is adequate for statistical analysis. This is corroborated by Fraenkel and Wallen (1996), whereby the minimal number of subjects for descriptive research is 100; for correlation research, it is 50; and for experimental and causal-comparative studies, it is 30 per group.

Focusing on knowledge and awareness of BIM among the sampled facility management companies, this research attempts to explain the organisation's expected benefits from BIM-FM integration and investigate the challenges for those intending to adopt the integration of BIM-FM at the early stage of the BIM project. The empirical datasets used for this study were derived from survey responses, so descriptive research is used (Karimian et al., 2019). Descriptive survey research is allowed when the questionnaire serves as the research instrument, and the research data are measured on an ordinal scale (Fellows & Liu, 2015). Statistical interpretation of the data through descriptive analyses enabled a better understanding of the outcome of the result. The questions require respondents to rate their agreement, perception, and attitude towards the statements using a five-point Likert scale. The empirical datasets comprised Likert scale evaluations for responses regarding the relative influence of stated advantages and disadvantages of BIM-FM integration (5 = strongly agree, 4 = agree, 3 = somewhat agree, 2 = disagree, and 1 = severely disagree).

3.3 Response Rate

Emails containing the project description and a survey link were sent to 196 facility management organisations, inviting them to join the research. The collection of data was conducted between March and May 2021. After two months of data collection, the researcher set May 2021 as a cut-off period for data collection for this research and proceeded to the data analysis stage. The overall response rate (March to May 2021) was 55.61% (n=109). According to Israel (1992), the consideration of sample size is the number required for data analysis. Almost any sample size will suffice when data is needed for descriptive statistics. In the meantime, Baruch (1999) discovered that the average response rate in academic studies was 55.6% through a comparative analysis of several investigations. Although the current study received a response rate of roughly 55.61%, it is acceptable for further data analysis to rely on the collected replies. The descriptive statistics of the organisation showed that all 109 respondents were appropriate for the next stage of analysis after the identification of misfit respondents (Table 1).

Table 1 Total number and percentage of overall responses

	Sample	Number of Responses	Percentage (%)
Registered FM with CIDB	196	109	55.61%
Unusable questionnaires	196	0	0
Usable questionnaires	196	109	55.61%
Overall response rate			55.61%

3.4 Validity and Reliability

As depicted in Table 2, the value of Cronbach 's alpha for perceived benefits instruments is 0.92. Meanwhile, for the perceived challenges instruments, a value for reliability is 0.975. The result is acceptable and reliable in measuring the potential of the FM's organisation towards integrating BIM-FM in Malaysia. In addition, an organisation's reliability between 0.90 to 0.95 denotes excellent reliability. The instruments developed for the perceived benefit and challenges of BIM-FM integration were reliable, and valid and formed a suitable measurement. The summary of the dataset's reliability test is shown in Table 2, with all the survey questions showing high reliability.

Table 2 Summary of reliability test of overall response

	Cronbach's alpha	Reliability	No. of Items
Perceived Benefit	0.92	High	21
Performance Improvement			
Communication and Collaboration			
Business Value			
Time and Cost			
Challenges	0.975	High	26
Organisational Challenges			
Process and Policy Challenges			
Technology Challenges			

3.5 Descriptive Analysis

This research applied descriptive analysis to analyse data using frequencies or percentages of samples' distribution. Tables, charts and figures are used to illustrate the analysis of this study in a more meaningful way. The scrutiny begins with respondent profiles and the demographics of the organisation. The profiles of the respondents were thoroughly assessed based on their basic comprehension of the existing practice and BIM technology in Malaysia. Meanwhile, the FMs organisation background is analysed on the organisational structure and the organisation's behaviour towards BIM technology. Then, the FM organisation's perspective on the potential benefits of integrating BIM-FM at the initial phase of the BIM process was evaluated. The last part of this descriptive study examines the obstacles that prevent the FM organisation from integrating BIM-FM.

4.0 FINDINGS

4.1 Respondent's Profile

Table 3 Respondents' demographic information

	n	%
Age		
Less than 30 years	16	15
31 to 40	54	59
41 to 50	36	33
51 to 60	2	2
61 or more	1	1
Qualification		
Diploma	10	9
Degree	71	65
Master/PhD	25	23
Others	3	3
Working years in current organisation		
Less than 5 years	26	24
5 to 10 years	33	29
10 to 15 years	26	24
15 to 20 years	14	13
More than 20 years	10	10
Awareness on BIM usage in the construction industry		
Not all aware	7	7
Slightly aware	21	19
Somewhat aware	31	28
Moderate aware	36	33
Extremely aware	14	13
Knowledge of BIM		
Not at all knowledgeable	9	8
Slightly knowledge	21	19
Somewhat knowledge	52	48
Moderate knowledge	21	19
Very knowledgeable	6	6

This section provides background information on the respondents, including their age group, academic history and years of facility-related experience. This information explains the traits of the survey respondents, which is important in establishing the validity of the research's conclusions. Tables, pie charts, graphs, and figures were used to show how the responses were distributed. The demographics of the respondents are summarized in Table 3. According to the findings, most respondents (57%) are between the ages of 31 and 40. The demographic data shows that most of the respondents are middle-aged and have experience with the current organization ranging from five to 10 years. Most respondents (65%) had at least a bachelor's degree, so it can be said that the respondents' age, proper university education, and sufficient job experience in the FM industry make them qualified to represent their organization. To gauge their understanding and knowledge of BIM, additional analysis and documentation were executed. In response to inquiries about their knowledge of BIM, 33% of the respondents reported they had only a general understanding while 48% reported they were knowledgeable. 48% of them were knowledgeable about BIM. The survey revealed that the FM practitioners' initial knowledge and awareness of BIM technology are already in place but still considered minimal.

4.2 Organisations' Information

Table 4 Organisations' demographic information

	n	%
Total years of organisation establishment		
Less than 5 years	5	4
5 to 10 years	13	12
10 to 15 years	17	16
15 to 20 years	15	14
More than 20 years	59	54
Number of staff		
Less than 20	7	6
20 - 50	9	8
50 - 100	9	8
100 - 150	15	14
150 or more	69	63
Nature of current organisation		
FM Consultant	16	15
FM Contractor	57	54
General Contractor	6	5
Property Management	20	19
Developer	7	7
Support for BIM training/courses/seminars or others		
Yes	77	71
No	32	29
Level of BIM implementation in an organisation		
Not interested in implementing BIM	16	15
Interested, but currently do not have any structured strategy to implement BIM	44	40
Not implemented, but currently exploring the implementation of BIM	22	20
Not implemented, but currently having a structured plan to implement BIM	5	5
Have been implementing BIM	22	20
Projected time frame		
Not interested in implement BIM	11	10
More than 5 years	31	28
Within 5 years	33	30
Within 3 years	11	10
Within 1 year	3	3
Have been implemented	20	18

Since this study is a pioneering scrutiny of BIM adoption and BIM-FM integration in facility construction and management organizations in Malaysia, it is crucial for academic research to profile the organization. The demographic data for the organizations is shown in Table 4. This survey showed that 54% of organisations had been established in the industry for over 20 years, and 63% had over 150 staff. Meanwhile, 57 out of 109 respondents who took part in this survey were FM contractors. This leads to the conclusion that the organizations engaged in the study are established and mature. Further investigation revealed that FM organisations (71%) have already sent their staff to a seminar, training, or seminar on BIM. This shows awareness of BIM technology, thus revealing that the FM organisations in Malaysia have taken the initial initiative to invest in BIM training and knowledge. As reported, for the level of implementation of BIM, forty-four (44) of the organisations were interested in implementing BIM. They currently lack a structured strategy to implement BIM. The most exciting result from the survey is that most respondents (30%) showed that the projected time frame to implement BIM in their organisation is within five years. This reveals that the FM organisation in Malaysia has an optimistic and open mind to adopting BIM in the future.

4.3 Benefits of BIM-FM Integration at the Early Phase of BIM Project

Many advantages of adopting BIM were recognized by the published research and the qualitative interview. The goal of all these advantages is to raise productivity by producing more efficient processes and services that are more useful. Thus, the potential of integrating BIM into FM practices offers concrete advantages for performing the building throughout its life cycle. This section discusses the respondents' level of agreement towards the benefits of integration of BIM-FM in the early phase of the BIM project. Performance enhancements, participation and communication, the value of the business, money and management of time are the four distinct aspects. The benefits of integration for performance improvement are broken down into two categories: (1) managing maintenance and building performance, and (2) managing information. The findings of the survey are presented in Table 5. As a result, 81% of the respondents agreed organisations will benefit from integrating BIM-FM at an early stage of the BIM project. With a mean score of 4.17, controlling operation and maintenance activity and increasing building performance are the two key perceived benefits gained from the study on performance elements. Saving money and time spent looking up FM data comes in second with a mean score of 4.16. Meanwhile, factors such as improved accuracy and quality of data and reduced duplication of asset and maintenance information both recorded a mean score of 4.15. According to the results, the FM professionals identified better building performance laterally in terms of efficiency and effectiveness of data and information management for the life cycle of the building as a significant perceived benefit of integrating BIM-FM at an early stage of BIM projects.

Table 5 Mean, standard deviation and rank for benefits of BIM-FM integrationn

Performance Improvement	Mean	Standard Deviation	Rank
Improve building performance and manage O&M activities	4.17	0.764	1
Improve the accurateness and quality of the O&M data transfer	4.15	0.780	3
Reduce duplication of maintenance and asset information	4.15	0.756	4
Improve the current transmission handover process	4.12	0.766	5
Increase the maintenance strategy	4.09	0.800	6
Improve the ability to capture, integrate and access visual data	4.09	0.752	7
Improve strategic asset planning and decision making	4.07	0.778	8
Quick and right decision based on authenticated real-time data	4.07	0.754	9
Seamless flow of information exchange and transfer	4.06	0.749	10
Improve the quality of O&M documentations	3.95	0.821	17
Improve building sustainability analyses	3.94	0.780	18
Reduce the needs for repairs and alterations in life cycle of the building	3.88	0.858	20

4.4 Challenges of BIM-FM Integration at the Early Phase of BIM Project

Table 6 Mean, standard deviation and rank for organisation challenges

Organisation Challenges	Mean	Standard Deviation	Rank
Low level of adoption due to poor awareness about BIM	4.34	0.784	1
Lack of BIM knowledge on the requirements for the integration process	4.29	0.737	2
Lack of true understanding of what BIM-FM integration is	4.27	0.753	3
Lack of client demand to use BIM	4.24	0.781	4
Lack of real cases and positive return investment	4.23	0.741	5
Lack of BIM specialist in FM industry	4.22	0.798	6
Not adequately prepared to engage in BIM projects	4.21	0.783	7
Cost correlated to software purchases, hardware upgrades and training	4.21	0.746	8
Unclear benefit gain from the integration	4.09	0.856	9
Ignorance of FM team by the design and construction team	4.02	0.85	10

Table 7 Mean, standard deviation and rank for process challenges

Process Challenges	Mean	Standard Deviation	Rank
Improper building information capture from design stage to the O&M stage	4.17	0.764	1
Lack of appropriate guidelines for the integration process	4.17	0.764	2
Unclear BIM-FM workflow for integration of BIM in FM	4.16	0.735	3
Process and policy challenges organisation at the early phase of BIM project	4.14	0.775	4
Lack of collaboration between project stakeholders	4.11	0.737	5
Lack of contractual framework for the integration process	4.1	0.781	6
Lack of standard and protocols in determining the specific data required	4.09	0.727	7
Lack of clarity in ownership and responsibility of the as built model	4.06	0.773	8

Table 8 Mean, standard deviation and rank for technology challenges

Technology Challenges	Mean	Standard Deviation	Rank
Lack of standardized data libraries and open system	4.04	0.827	1
Interoperability between FM system and BIM technology	4.01	0.799	2
Inappropriate technologies within the organisation and reluctance to use open standards for information exchange	3.98	0.805	3
The diversity between multiple BIM and FM tools and platforms	3.94	0.785	4
Different software used for BIM-FM integration	3.94	0.768	5
Lack of compatibility between BIM and existing asset management systems.	3.93	0.857	6
Software issues - new version of software not compatible with old version	3.92	0.873	7
Incompatible file exchange format	3.84	0.873	8

This section discusses the findings regarding the challenges of BIM-FM integration, which is categorised under Organisation, Process, and Technology. From Table 6, the item with the greatest mean score (4.34) among the obstacles faced by the organization was the low degree of BIM adoption in the FM business, whereas the item: ignorance of the FM team by the design and construction team was recorded with the lowest mean value (4.02). The mean of 4.17 was the highest in the process context because of the inadequate capturing of building information from the design phase to the maintenance and operational stage and the lack of integration process regulations (Table 4.7). For the item showing the absence of unambiguous ownership and responsibility of the as-built model, the lowest mean score (4.06) was recorded. In technological challenges summarised in Table 8, the items with the highest mean score (4.04) were lack of standardised data libraries and open systems, while incompatible file exchange formats reflected the lowest mean score of 3.84. The outcomes show that the FM organisation's unwillingness to execute BIM-FM is mainly because of organisational matters rather than process and technological elements. The construction industry in Malaysia still lacks a basic understanding and awareness of BIM-FM integration among FM organizations. As a result, there is a need to raise BIM technology understanding in the FM sector, particularly through the early involvement of FM workers, to improve facility performance.

5.0 DISCUSSION

Most facilities management (FM) companies in Klang Valley offer facilities services in building operation and maintenance, either as primary FM contractors, in-house FM teams, FM vendors or FM consultants. The regional breakdown of the response rate is crucial for advancing BIM-FM integration knowledge and awareness in some targeted locations while propelling growth in others. According to the findings of the Malaysia Building Information Modelling Report (CIDB, 2020), various implementors are in the central region. Selangor recorded the highest number of BIM implementors with 35%, followed by the Federal Territory of Kuala Lumpur (28%). There are several BIM implementors in the Klang Valley because it is where most mega-projects are being worked on.

The findings of this study are significant to other studies conducted in Malaysia by several researchers addressing the advantages and difficulties of BIM in the Malaysian construction sector using the same method of data analysis. Gardezi et al. (2014) have identified and prioritised the challenge of implementing BIM in the Malaysian construction industry. A developed questionnaire was used to collect the data, and a literature analysis was used to identify the determinants and challenges to BIM implementation in the construction sector. Jamal et al. (2019) used a questionnaire survey to learn about the trends and viewpoints of architectural firms. The results show that Malaysian architecture businesses are implementing BIM. Neng et al. (2021) identified the obstacles to incorporating FM consideration throughout the building stage in the study, which involved FM contractors in Selangor. The researcher also recommended alternative approaches to improve the integration of FM.

Because of the need for more reports or tangible case studies highlighting the benefits of BIM, the Malaysian construction industry still needs help in understanding the benefits of implementing BIM in their practice (CIDB, 2015). The BIM report by CIDB in 2020 states that even though architects are the top users of BIM, their overall adoption rate is only 19%. The report shows the need for BIM knowledge and experience as critical issues for BIM adoption. This event occurs when the industry needs to understand BIM clearly. A study conducted by Latiffi et al. (2016) revealed that a lack of knowledge and abilities in BIM would decrease construction players' productivity. According to Jamal et al. (2019), the need for a skilled BIM workforce is a factor impeding the adoption of BIM by architects.

Apart from that, "no established contractual framework for BIM" is one of the biggest challenges to implementing BIM. NBS (2019) also recorded that almost 36% and 48% of the respondents in the UK and Ireland agreed about having the same issues when there is no established contractual framework for working with BIM. Also reported is a problem of the need for clear policies supporting BIM implementation, which is one of the central issues because it could lead to unproductive and slow adoption of BIM for the projects (CIDB, 2020). In their comparative study on perceived benefits and challenges for Civil and Structure consultant engineers, Ang et al. (2020) concurred that BIM can minimise interference time, reduce cost, and enhance management performance. However, they also specified that the obstacles to adopting BIM were a need for more information, experience, and support from upper management and high adoption costs, which impeded the growth of BIM.

Overall, this study's findings revealed that BIM substantially affects the FM industry and aids in supporting the delivery of facilities management. As Al-Kasasbeh et al. (2021) discussed, integrating BIM in FM for building asset management is essential, especially during the decision-making stage, to ensure the facility's assets are well-maintained and sustained for the long-term phase.

5.1 Perceived Benefits

Although BIM technology is still at the beginning of its application in the FM phase, the feedback from the FM practitioners is amazing. Whether they are not yet exposed to the BIM technology at the O&M stage or just have experience with BIM in design and construction or based on their experiences with BIM, they show their expectation of BIM on what benefits they think BIM can bring to the FM phase. Their opinions, as discussed below. The survey's findings point to four major advantages of incorporating BIM and FM in the first stages of a BIM project.

First, the FM practitioners believed the integration will improve the performance of FM services delivery and information management. When BIM-FM integration is established early, all the information from inception to demolition is well distributed and organised. This study is aligned with the existing findings by Hoang et al. (2020) who discussed the benefit of BIM implementation for FM in the Vietnamese context. When this is performed appropriately, it will ensure reliable data that can better the asset's operation and maintenance during its entire life (Ashworth et al., 2016). Early integration of BIM-FM can be effectively used for instant access to accurate and quality data, simple information, and better exchange of information (Ashworth et al., 2016). By adopting BIM-FM, the potential to track all previous history of the assets is facilitated, given that all data is stored in the system. The relevant data, such as information about the supplier and details of the spare parts, are supported by integrated BIM-FM. All the data are kept in the centralised system. This investigation is consistent with preceding studies, which showed that integration at the beginning level helps improve resources and accumulate information regarding that facility. This resulted in good building performance conditions to give an excellent experience to the user. The early involvement of FM in sustainability issues will support the FM team to advise the design team in supporting energy saving in selecting the best material and facilitating building analysis, especially in sustainability initiatives areas.

The second benefit that the FM practitioners agree upon is communication and collaboration. By having excellent communication and collaboration, integrating BIM-FM will improve project understanding and coordination amongst the major stakeholders in the construction industry from the early stage. Collaboration and efficient teamwork are at the core of the ISO 19650 series, according to UK BIM Alliance (2019). Collaboration between all stakeholders, especially the design team, resolved many issues, such as space management and clash-free design. By using BIM as a real-time visualisation tool, it has the potential to visualise the spaces in 3D visualisation of the asset and its location. Thus, integrating the BIM-FM will increase, improving the marketing strategy, and empowering the decision-making process. experience to the user. The early involvement of FM in sustainability issues will support the FM team to advise the design team in supporting energy saving in selecting the best material and facilitating building analysis, especially in sustainability initiatives areas.

Efficiency in time and money was the third advantage of including the FM team early in the BIM process. BIM will give the FM team access to digital information on the FM from a single source, which could cut down on the time and expense associated with obtaining the information from fragmented sources (Matarneh et al., 2019). This study highlighted that the integration process would reduce the time to fill information into the FM system and save overall operating and maintenance costs by understanding costs and utilisation with increased energy and operational savings opportunities. Wang et al. (2018) concluded that early FM team inclusion significantly decreased building life cycle costs. Automating updating and data transfer through BIM-FM integration. The FM team gained access to digital information on the FM in a single source and avoided labour costs for data entry and attribute transfer to CMMS by being included early in the BIM process. These events will cut down the time spent retrieving appropriate data.

The last benefit of BIM-FM integration is to streamline the business process across the operation and maintenance life cycle. Mayouf et al. (2014) concluded that early participation of the FM crews is limited and should be considered during the decision-making process. This opportunity is made possible by the FM team's involvement in the early stage. The suggested FM data would make the design team and BIM coordinator more aware of the data that needs to be gathered throughout project delivery to guarantee high-level building performance. According to Wang et al. (2018), BIM technology offers knowledge-sharing platforms through improving stakeholder engagement and communication. The FM team can quickly determine the design that satisfies the O&M needs, building functions, and business objectives using 3D visualisation. They can therefore offer suggestions for enhancing the design. Other than that, BIM can help with other FM tasks, including space management, market research, customer satisfaction surveys, and creating leasing agreements (Miettinen & Paavola, 2014).

According to their expertise and experience with BIM, the FM representative gave the statements above. The AEC industry has adopted BIM at a rapid rate, which has been helpful to contractors. No perceivable benefits have been identified in the Facility Management sector. The benefits of BIM-FM integration inherit all the benefits from the previous stages, which is the design and construction phase. Once BIM-FM is applied in the operation phase, it also brings long-term benefits when it is aligned with the organisational objectives and the FM organisation is ready for the change. Integrating BIM-FM will facilitate the effective resolution of interoperability issues of data transfer and also save the life cycle cost of the building.

5.2 Challenges

Most of the investigations on the barriers of BIM implementation are concerning the FM organisations' BIM maturity and the results were focusing on the low, average, and high maturity. Through this study, the issues associated with BIM-FM adoption were determined through the literature review, and the outcomes uncovered that the hindrances restricting the integration of BIM-FM from the FM practitioners in Malaysia could be classified into three: People/Organisation, Process and Standard, and Infrastructural Technologies.

5.2.1 People/Organisation

The main structure of hurdles refers to the organisation's or people's readiness and capability to use BIM-FM integration, which is influenced by internal incentives such as readiness for BIM implementation and knowledge, skills, and culture. We have noted a lack of customer needs using BIM as one of the key barriers to external stimulation (Rae et al., 2019; Shen et al., 2016). Individuals must be familiar with BIM and technology because BIM is new in FM. Lack of information may cause ignorance and unfamiliarity with BIM technology. This research backs up the findings of Durdyev et al. (2022) that the cost of BIM in FM in New Zealand and a lack of familiarity with the technology were barriers to its implementation. The lack of technical professionals available to perform the integration process hinders FM personnel from acquiring knowledge about BIM requirements. The organisation's or people's need for more readiness and capability to use BIM-FM integration caused by internal incentives, such as readiness for BIM, delayed the use of BIM technology. Durdyev et al. (2022) and Edirisinghe et al. (2016) thus emphasise the significance of the crucial role of awareness and knowledge in adopting BIM in FM. Thus, the effectiveness of the BIM-FM integration depends heavily on the early involvement of FM in the BIM process, which is related to behaviour, attitude, motivation, and trying to change ways of thinking. In addition, the FM sector needs to improve BIM knowledge and skills and the digital technology skills of FM personnel.

5.2.2 Process and Standard

Even though ISO 19650, a standard that serves as a guide for the asset information distribution process, does exist, its feasibility is yet unknown. According to Dixit et al. (2019), the absence of guidelines, protocols, and standards for BIM in FM continues to be a major barrier for all stakeholders. Malaysia is having difficulty in combining BIM and FM because there is no set of rules or standards for how to use BIM in FM. FM professionals concurred that the lack of a defined procedure for the integration process contributes to the complexity of the integration process. This is in line with the findings of Wijekoon et al. (2020), who found that implementing BIM in FM practice was hindered by the absence of standard work practises and the ambiguity of BIM-related procedures, such as defining roles and responsibilities and workflow. Early BIM-FM integration represents a novel area of work that is not present in conventional work practices, is not yet a widely used procedure in the FM industry and causes a significant amount of time and effort to explain the goals and methods of the integration process to the FM personnel.

5.2.3 Technology in Infrastructure

Despite being less visible, technical issues remain a major obstacle to the successful implementation of the BIM-FM integration project. The survey showed that compatibility problems and the abundance of different software, tool, system, and platform packages for BIM and FM made integrating BIM into FM in the early stages of the project difficult. Notably, the data that needs to be transmitted might not work with other systems or those currently in use. According to the research conducted by Rae et al. (2019), there are limitations placed on the use of BIM technologies in FM practices because of the misalignment between those two types of working procedures. Matarneh et al. (2019) found that transferring information between BIM models and FM systems is complicated. To facilitate the simple exchange and transfer of FM systems, it is proposed that all project participants follow the same approach to data structuring. To simplify the process and give FM personnel confidence, someone should specify data interchange formats beforehand to promote interoperability and data transmission between systems.

6.0 CONCLUSION

The FM industry had a lot of data and knowledge about the building in use today, but it was massive, scattered, and not integrated. Improved performance, enhanced communication and collaboration among the key stakeholders, increased business value for the FM organization, and better time and cost management are all advantages of integrating BIM technology into FM. Nevertheless, in present practice, where BIM technology is used for the project, the BIM model's data does not support FM operation since it does not have the FM information requirement. FM teams asserted that they lack BIM knowledge, are unable to transfer data from BIM models to FM systems and are experiencing interoperability problems. Therefore, it is not easy to integrate the BIM-FM in the early stages of the BIM project. As a result, this study intends to present a thorough explanation of the perceived benefits and challenges. This study evaluated the advantages and significant obstacles of BIM in FM through a survey of FM practitioners and descriptive analysis.

The benefit of this study is that it raises awareness of BIM-FM integration among FM sectors and helps to clarify the opportunities and difficulties associated with the integration process. The results of this study should encourage more FM businesses and organisations to use BIM-FM integration. FMs must get involved early to help clients set up their BIM strategy and precisely identify the information requirements to reap the rewards. The major goal of integrating BIM-FM at an early stage of a project is to fully utilise FM's BIM capabilities. To support effective and efficient building operation and maintenance activities, the FM team must have access to accurate, complete information. By establishing a single platform that includes all the data sources required for FM operation in one system, BIM in FM will improve facility management. To enhance the adoption of BIM-FM integration in the FM business, it is required to raise the degree of perceived benefits among FM stakeholders.

Notwithstanding, several factors were demonstrated to influence the barriers to the BIM-FM integration at an early phase of a BIM project. This could be attributed to the enormous obstacles that need to be addressed in adopting integration BIM-FM before reaping the benefits. The unresolved issue that needs to be addressed for the success of BIM-FM integration such as information exchange, interoperability, a gap in understanding the integration requirements process, and legal and standard for the integration process remains the main issues.

According to the present research outcome, knowledge is the critical gap for the early integration of BIM-FM and required to be more BIM training and education for the FM sector. There is a need to dispel the misconception that BIM is not just about software but also an overall process, information, and data quality to dispel the skepticism around integrating BIM-FM. Further research is needed to investigate the advantages and problems that prevent proper acceptance of BIM-FM integration in the early stages of a BIM project.

The following are the three main contributions of this study. The paper initially examines the advantages of BIM-FM integration and the restrictions for BIM and FM practices integration in Malaysia. Second, according to Brown and Dant (2008), a major contribution to the body of knowledge is made when new knowledge is added by filling in knowledge gaps that already exist. Another significant effect of this work is that it illuminates and offers insight into the possibilities and difficulties of integrating BIM and FM practices in Malaysia, which is currently in line with the 4th industrial revolution's transformation of the industry into facility management.

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