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Awareness on BIM-FM Integration at an Early Stage of The BIM Process Amongst FM Organisations in Malaysia

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ABSTRACT

This paper examines the awareness on Building Information Modelling-Facility Management (BIM-FM) integration towards the inclusion of the FM team at the early phase of the BIM process amongst FM companies in Malaysia. Primary data used for this study were sourced through a questionnaire administered to 196 FM companies in Klang Valley that are registered with the Construction Industry Development Board (CIDB) under category Facility (F) specialised in General Building and Infrastructure Facility (FO1) and Health Care Facility (FO2). There were a total of 109 respondents who answered the survey, which was distributed via email in March 2021. The data were analysed using frequency analysis. To ascertain the awareness of integration BIM-FM at the FM organizations, consideration towards the level of awareness of BIM Level of Detail (LoD) is needed. The results revealed that respondents have a moderate level of awareness on BIM-FM integration at the early phase of the BIM process measured towards the perception of BIM-FM integration, defining the BIM-FM information requirements needed as well as the utilisation of BIM to support FM practice. Thus, the findings of this study provide the industry with information on current levels of understanding of BIM-FM integration at an early phase of the BIM process by FM organisations.

Keywords:
BIM-FM Integration; Early FM Involvement; Level of Awareness

1. Introduction

Building Information Modelling (BIM) has been identified as part of the technology behind the industry 4.0 revolution in Malaysia's construction industry [1]. The BIM technology Construction Industry Transformation Programme (CITP) blueprint, spearheaded by the Ministry of Works and Construction Industry Development Board (CIDB), has digitally transformed the construction industry. BIM technology is pivotal in the creation of intelligent data throughout the life-cycle project. With the release of the BIM Guide and Roadmap that aligns with the national agenda, CITP aims to transform the Malaysian construction industry by implementing Stage 2 BIM maturity inwards 2020 [2]. Thus, the application of BIM for Facility Management (FM) is recommended in the Malaysian built environment sector to be implemented mandatorily. Therefore, the integration of FM organisation at the early phase of the BIM project is expected. The full engagement of BIM technology will bring great potential to assets and estates [3].

Despite industry awareness of the potential of BIM, however, the FM industry is yet to utilise it and currently facing slow change in the BIM implementation. Understanding how to apply BIM into

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FM is limited, and many researchers mainly focus on its implementation in the design and construction phase [4]. BIM into FM is considered new in terms of FM industry awareness, as suggested by [5] that FM practitioners need to catch up with BIM very early to benefit from BIM technology in delivering the right and valuable information to ensure the building is sustainable.

However, to have a sustainable building from design to demolition that looks beautiful is well-made and delivers the operational services to its end-user, all stakeholders need to engage themselves throughout the process. Facility management teams are limited in their ability to support building performance and need to be involved in the planning and design. By adopting BIM provides the opportunity for this to happen. Integration BIM and FM provide the FM teams with a good starting point in capability and capacity to access the correct information at the right time and in the suitable format and enable better decision-making and delivery of more efficient and effective information exchange through collaborative working practice.

The fundamental of the BIM-FM integration process is gathering all the information needed throughout the project lifecycle through operational delivery and assets management strategy. Therefore, it is essential to prepare an information delivery plan to define the flow of information across the project stages and supporting data transactions. The inclusion of information needed for the operation and maintenance stage at the early phase of the BIM process will raise the awareness for other BIM stakeholders of the information collected through building delivery [6]. The success of FM is based on an accurate and reliable dataset of the buildings and their attributes information. BIM allows integration of information throughout the building lifecycle from the design stage and equips a facility manager with precious information about the building to support the FM process efficiently in fulfilling the organisational goals. [7]

A BIM-FM Strategy Concept Model suggested by Ashworth[8] explained the roles of FM and the flow of the information needed in the BIM process. The model has clearly defined roles and responsibilities of FM teams through early inclusion of them in defining asset management strategies such as Organisational and Asset Information Requirements (OIR and AIR). According to the information requirement process, at each stage within the planning, design and construction phase, the objects in the model development, as needed or stated are laid down in the Employer Information Requirement (EIR). EIR is a document that sets out the information to be delivered and should be utilised through all project tiers [8]. The EIR needs to be created as early as possible before design teams and construction suppliers are appointed. Then, the EIR will be a part of the contract document, which will be used by the design and construction team to produce their BIM execution plan (BEP), stating how they will meet the information needs as laid out in the EIR [8]. The leading objective development of BEP is to stimulate planning and direct communication by the project team during the early phase of a project and explain how the information modelling aspects of a collaborative arrangement are carried out.

All this precious information is representing through a defined Level of Development (LOD). American Institute of Architect stated that the LOD is designed as a project milestone to determine a model component's geometric and non-geometric information [9]. The information contained in LOD ensures that the model prepared by all the stakeholders contains all the information and geometry needed for every BIM use to be applied. A LOD is a code assigned to each building component or system at each progressive stage of the project, so all the stakeholders know what to expect. However, not all the information's are needed at the operation and maintenance stage. Only data that are relevant to the operation and management (O&M phase is transferred into Asset Information Model.

A BIM Use can be defined as "a method of applying Building Information Modeling during a facility's lifecycle to achieve one or more specific objectives. It is apparent in the information delivery

plan that the use of BIM is considerable across all phases of the project lifecycle. Kyeider and Mesnner [10] has identified 25 BIM uses organised by the project phase of project development and classified them into four major categories: planning, design, construction, and operation stage.

Each stage has significance to the integration process of BIM-FM. As noted in previous studies, the involvement of FM during the planning stage can potentially reduce future maintainability issues during the O&M phase. The accuracy of the information given at this stage also will be beneficial to the quantity surveyor to produce cost estimates for the project.

The inclusion of FM in the decision-making process will add value to the facility by ensuring "less rework" and save the cost due to reduction in design alteration and rework. Meanwhile, as argued by most researchers, the involvement of FM teams in the construction process can help maximise sustainable construction potential. When properly integrated, BIM-FM at the early phase can provide many benefits to a project. The value of BIM-FM integration is illustrated through well-planned projects that yield: increased design quality through effective analysis cycles; greater prefabrication due to predictable field conditions; improved field efficiency by visualizing the planned construction schedule; increased innovation through the use of digital design applications; and many more. At the end of the construction phase, valuable information can be used by the facility operator for asset management, space planning, and maintenance schedule to improve the overall performance of the facility or a portfolio of facilities.

Technically, the awareness of BIM in the FM industry has been arising in the organisation in the early stage for rapid adoption of BIM as reported in the National BIM Report 2016 [11], where knowledge on BIM is still minimal, despite the awareness of BIM in the construction industry. On the other hand, the slow adoption of BIM in the FM industry might also be related to the awareness, perception of usefulness, compatibility with the new technology (BIM) and the fear of users' changes. Therefore, there is a need to provide a comprehensive understanding of the integration process to create an awareness of BIM in the FM industry. Accordingly, this study investigates the facility management organisational awareness of BIM-FM integration related to the perception, information needed, and the uses of BIM for early involvement of FM in the BIM process.

2. Methodology

The methodology used in this paper is based on the quantitative method. The research design for this paper is survey research. This paper applies the purposive sampling method, where the samples are selected based on the knowledge of a population and the purpose of the study. The population of this paper is the facility management companies operating in Klang Valley and registered with Construction Industry Development Board (CIDB) under category F specialised in carrying out works for general building and infrastructure facilities (F01) and healthcare facilities (F02).

Data used for the paper are sourced through questionnaires administered on the FM service providing organisations. The questionnaire is structured taking into consideration elicitation personal details, capturing the profile of the FM companies and ascertaining the respondents' level of awareness of BIM integration FM in their organisation. The awareness on the BIM-FM integration are assessed through the organisation's level of awareness of BIM Level of Development (LoD), perception of the integration and the understanding of the integration towards the utilisation of BIM-FM for the entire FM industry.

Preliminarily analysis was done by checking the returned questionnaires to ascertain that only usable data is included for the statistical analysis. The usable questionnaires are then finalised for coding and data entry in the statistical analysis software, SPSS. Data screening missing values,

examining outliers, and assessing normality for the data distribution were conducted using SPSS software.

The population identified for the research is 780 Facility Management organisations registered with the CIDB in 2020. Thus, the sample unit for analysis for the research is a facility management company representing Malaysia's construction industry, which will subsequently refer to as the 'organisation'. There are 500 registered facility companies with head offices located within Klang Valley, and most of these registered facility management companies are still active in the facility business. According to Krejick and Morgan [12], according to the size sample suggested, if the total population is 500, the size sample appropriate is 217. However, due to the pandemic Covid19 and the Movement Control Order (MCO) implementation 2.0 which started from January 2021 and extended untill May 2021, this has become a constrain in data collection process. However, there are some of the previous researches which stated that the minimum number of subjects believed to be acceptable for a research depends upon the type of research involved. This is supported by Fraenkel [13] who stated that, a minimum number of subjects for the descriptive study is 100 samples, 50 samples for correlation study and 30 in each group of experimental and causal-comparative studies.

An invitation to participate in the research has been sent out to 196 organisations through email, which contained a project description and a link to the survey. Within these two months (March to May 2021), the total response rate for this study was 55% (n=109). Even most studies are biased towards choosing small sample sizes but emphasises that sample sizes constitute just 50% of the minimum requirement to draw the conclusions the studies claimed. As this research has an approximately 55% response rate, it is considered satisfactory for related data analyses to rely on the received responses. Regarding the validity and reliability test, the value of Cronbach's alpha is at 0.98, which is high and considered acceptable reliability in measuring the potential FM's organisation's towards integrating BIM-FM in Malaysia.

All the questions request the participants to evaluate their response to a five-point Likert scale on the attitudinal, perception, and agreement statements. Concerning the FM knowledge and persuasion of BIM, this research tries to understand the perception of BIM by FM among FM organisations towards their awareness and willingness to adopt the innovation of BIM. Therefore, the demographic instrument is an essential step to identify potential early adopters of BIM-FM integration at the early phase of the BIM project.

Descriptive analysis is applied to analyse the data for this study, in which frequencies or percentages samples' distribution are described using tables, charts and figures. Descriptive analysis is essential to interpret the data statistically. Ultimately, the patterns that emerged from the data analysis could be translated in a more meaningful way. It starts with an analysis of the respondents' profiles and organisation demographics. The respondents' profiles are specifically assessed based on their years of experience in the current organisation, level of awareness, and general knowledge of the BIM industry.

The demographic information instrument for this study was structured for several purposes, such as determining the development of a profile of potential FM organisations towards integrating BIM in the FM industry, especially the involvement of FM teams at the early phase of the BIM process. In profiling, the BIM-FM integration evaluation on the awareness of BIM-FM integration at the early phase of the BIM process based on their organisation's knowledge in BIM towards their perception on the integration, understanding of information and terminology of BIM needed for the integration, and BIM uses in project stages for FM process.

3. Results

3.1 Respondents' Profile

This section describes the respondents' background information regarding their personal information such as age, educational background, years of experience in the facility industry, professional background, current roles in organisation, and the nature of business of their current organisation. This information, to some extent, explains the characteristics of respondents for this survey, which has significant roles in determining reliable outcomes are established for this research. The results show the distribution of responses using tables, pie charts, graphs and appropriate figures.

Table 1 shows a summary of the respondents' demographics. It can be concluded that the majority (57%) of the respondents aged between 31 to 40 years. Further analysis on the highest tertiary education shows that the majority of the respondents (65%) have at least a Bachelor's degree qualification. The majority (30%) of the respondents have 5 to 10 years of experience working in the current organisation. Additional characteristics of the respondents are also collected to identify their awareness and knowledge of BIM. When the respondents are asked about their rate of awareness of BIM, most of the respondents (33%) have a slight or lower awareness of BIM. Meanwhile, the level of their knowledge on BIM, a majority (48%) of them have some knowledge with BIM.

Table 1
The Summary of Respondents' Demographic Information

	n	%
Age		
Less than 30 years	16	15
31- 40	54	59
41 -50	36	33
51 - 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 -10 years	33	29
10 – 15 years	26	24
15 – 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

3.2 Organisation Information

The profiling of the organisation is essential to academic research since this study represents pioneering work that surveys BIM adoption in construction organisations in Malaysia. Table 2 shows the organisations' demographic information. The majority (54%) of the respondents are more than 20 years of establishment in this industry of which 63% having more than 150 staff at their organisation. Most of the respondents in this survey are FM contractors (54%). Further, the result showed that most (71%) of the organisations had sent their staff to a seminar, training, or seminar on BIM. In terms of implementing BIM in an organisation, the majority (40%) of the organisations were interested in implementing BIM. Still, they currently do not have a structured strategy to implement BIM. The most exciting result from the data is that the majority of the respondents (30%) had implemented or projected to implement BIM in their organisation within five years.

Table 2
The Summary of Organisation 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
Numbers of staffs		
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

3.3 Awareness of BIM-FM integration

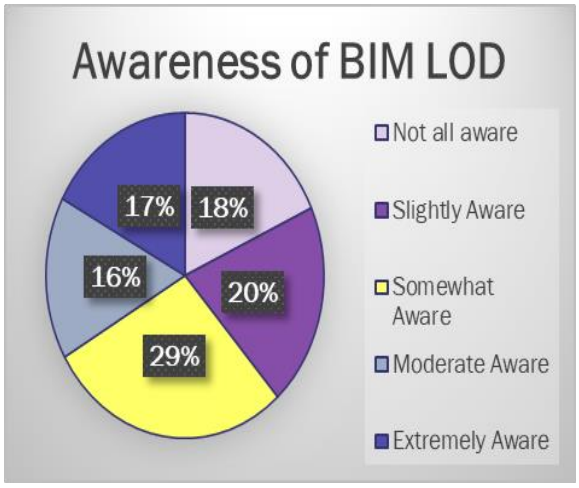
This section is to rate the awareness of the FM organisation towards the integration of BIM-FM at the early phase of the BIM process. The section consists of four sub-sections to be rated by the respondents regarding their understanding of BIM-FM integration during the early phase of BIM in terms of perception, the information needed for the integration and the use of BIM for the FM process at the early phase of BIM project.

3.1.1 Awareness of Level of Development (LOD)

The level of BIM knowledge amongst the Facility Management organisation in Malaysia is determined based on their awareness of the BIM Level of Development (LOD). It is shown in Table 3 that 29% of overall respondents in this survey are somewhat aware of the LOD of BIM. Seventeen (17%) are highly aware of the LOD of BIM, and 16 % are moderately aware. Whereas 20% are slightly aware, and 18% are not all aware of the LOD of BIM. As a whole, it can be concluded that the awareness amongst the respondents is moderate on the Level of Development of BIM whether they are applying BIM technology in their organisation or not. Even though the revolution of BIM has

been globally diffused in the construction industry in recent years, BIM is still low in terms of implementation. Slow development in the FM industry in Malaysia might cause less awareness amongst those FM organisations.

Table 3
Distribution of respondents based on awareness of LOD



Level of awareness of BIM Level of Development (LOD)	Frequency (n)	Percentage (%)
Not all aware	20	18
Slightly Aware	22	20
Somewhat Aware	31	29
Moderate Aware	17	16
Extremely Aware	19	17
Total	**109**	**100**

3.1.2 Perception of BIM-FM integration

The participants are asked to indicate their perception on the integration of BIM-FM at the early phase of BIM process. These variables range from a negative perspective, i.e., the FM industry is not clear about the integration of BIM-FM to the positive impact in terms of process and technology. The participants are asked to rate their level of agreement or disagreement in relation to each variable. This is identified in Table 4 complete with the standard deviation and its ranking in relation to impact.

Table 4
Propensity Level of Mean Score

Mean Score	Level of Awareness/Satisfaction
1.00-2.33	Low
2.34-3.67	Moderate
3.68-5.00	High

Concerning research questions on facility manager's organisational awareness on the integration of BIM-FM in terms of perception, most respondents are "highly aware" of BIM-FM integration at the early phase of the BIM project with a mean value between 3.68 and 5.00 [12], as summarised in Table 5. A minority of them had only a moderate awareness level of BIM-FM integration with a mean value of 3.66. [12]

Overall, these results indicate that participants see BIM-FM integration at the early phase can support building operation and enables them to have access to all of the life cycle information of the projects and provide relevant information for the entire project cycle. Therefore, this survey revealed how important the FM team's inclusion in the early construction process is in supporting a value of information for the entire life cycle of the projects.

Table 5
Mean, Standard Deviation and rank for perception of BIM-FM integration

General perception on BIM-FM integration at early phase of BIM process	% Strongly disagree	% Disagree	% Neutral	% Agree	% Strongly Agree	Mean	Std. Deviation	Rank
Process for managing building operation for the entire project life cycle	0.9	1.8	11.9	56.9	28.4	4.10	0.745	1
Enables to obtain access to all of the life cycle information of the projects	0.9	0.9	13.8	56.0	28.4	4.1	0.732	2
Relevant and right information prepared for handover to the FM team.	0.9	0.9	13.8	57.8	26.6	4.08	0.722	3
Opportunity to give feedback on the decisions made at the early phase	0.9	1.8	16.5	51.4	29.4	4.06	0.785	4
Real-time collaboration among stakeholder	0.9	0.9	18.3	57.8	22.0	3.99	0.726	5
Contribute long term of life-cycle cost saving of the building	1.8	0.9	19.3	53.2	24.8	3.98	0.805	6
New dimension to building maintenance operations	0.9	3.7	18.3	54.1	22.9	3.94	0.803	7
Influence on energy performance and sustainability of the built environment	0.9	0.9	25.7	47.7	24.8	3.94	0.792	8
Investment and organisation's marketing strategy	0.9	4.6	33.0	47.7	13.8	3.69	0.802	9
The FM industry is not clear about the integration of BIM-FM	3.7	11.9	15.6	51.4	17.4	3.66	1.019	10

As a summary, it can be acknowledged that facility management players in Malaysian are aware of the BIM-FM integration. Most of them agreed that the integration of BIM-FM at the early phase

of the BIM process provides a repository of facilities information that will support FM during the operation of the whole life cycle of the building. FM organisation is aware of the capability of BIM-FM integration at an early phase of the BIM process in terms of data management, visualisation, managing operation and maintenance and saving project life cycle. However, there is still a significant number of respondents who are unsure how BIM-FM is used within the built environment process.

3.1.3 Information needed for BIM-FM integration

The next analysis assesses the level of awareness in determining the information needed for the integration. The FM organisation is advisable to clearly understand the information needed in BIM when working in a BIM-FM environment. Therefore, in this survey, participants are asked to rate their understanding and competency of the information needed during the BIM-FM integration.

Table 6 shows an overview of the specific BIM information terminology towards the BIM-FM integration process, with a moderate level of competence with mean values between 2.35 to 2.41. The information items are BIM Execution Plan (BEP), Employers Information Requirements (EIR), Organisational Information Requirements (OIR), Asset Information Requirement (AIR) and Project Information Model (PIM).

In contrast, only three information items have low levels of competence with mean values between 2.03 to 2.31, respectively, namely ISO 19650 -Part 1 – 3, Project Information Requirements (PIR) and Asset Information Model (AIM).

Table 6
The summary on information needed for BIM-FM integration

Information needed for BIM-FM Integration	**%**	**%**	**%**	**%**	**%**		
	Never heard	**Some knowledge**	**Fair knowledge**	**Competent**	**Highly Competent**	**Mean**	**Std. Deviation**
ISO 19650 -Part 1 - 3	44.0	24.8	18.3	10.1	2.8	2.03	1.134
BIM Execution Plan (BEP)	29.4	32.1	14.7	21.1	2.8	2.36	1.19
Employers Information Requirements (EIR)	31.2	30.3	12.8	17.4	8.3	2.41	1.314
Organisational Information Requirements (OIR)	33.9	29.4	11.0	19.3	6.4	2.35	1.301
Asset Information Requirements (AIR)	31.2	31.2	13.8	17.4	6.4	2.37	1.267

Project Information Model (PIM)	29.4	32.1	14.7	20.2	3.7	2.37	1.207
Project Information Requirements (PIR)	35.8	28.4	15.6	15.6	4.6	2.25	1.226
Asset Information Model (AIM)	33.9	28.4	14.7	18.3	4.6	2.31	1.245

The response related to the understanding of the information needed may be grouped into three types of respondents. The survey has revealed that a significant proportion of 44% of the participants has a moderate knowledge of the information needed for the integration, and 33% of the respondents never heard the terms of the information. Only 22% of the participants are competent or highly competent in determining the information needed to integrate BIM and FM.

What emerges from the result is most of the FM organisations in Malaysia were aware of the information need but at the same time do not know how the information flow and what relevant documents or information needs to be considered for the integration process. It also reveals three types of information that are not very familiar among the respondents: ISO 19650, Project Information Requirements (PIR) and Asset Information Model (AIM).

3.1.3 Uses of BIM in FM practice

BIM usage is a method or strategy of applying BIM during a facility lifecycle to achieve one or more specific objectives, including gathering, generating, processing, communicating, executing, and managing information about the facility. The level of BIM uses in the FM process is investigated to determine whether the respondents are aware of BIM technology. The statistical details of frequency and percentage of the importance of BIM usage for the FM process at an early phase of the BIM project amongst the respondents are shown in the following Table. 7. There are 25 common uses of BIM as identified by Kreider and Mesnner [10], which are then are classified into four (4) major categories, namely, planning phase, design phase, construction phase and operation and maintenance phase.

Table 7
The summary on the importance of BIM usage for FM process at early phase of BIM project

BIM usage for FM process at early phase of BIM project	% Not Important	% Low Important	% Neutral	% Very Important	% Extremely Important	Mean	Std. Deviation
Existing Condition Modelling	3.7	15.6	36.7	32.1	11.9	3.33	0.803
Cost Estimating	2.8	1.8	23.9	47.7	23.9	3.88	1.001

Phase Planning (4D Modelling)	3.7	13.8	33.9	41.3	7.3	3.35	0.889
Programming	3.7	3.7	3.7	3.7	3.7	3.14	0.937
Site Analysis	4.6	13.8	43.1	26.6	11.9	3.28	0.844
Design Authoring	2.8	7.3	38.5	46.8	4.6	3.43	0.999
Design Review	1.8	1.8	25.7	60.6	10.1	3.75	0.809
3D Coordination/Visualization	1.8	2.8	33.0	55.0	7.3	3.63	0.735
Engineering Analysis/ Other Engineering Analysis	1.8	3.7	38.5	41.3	14.7	3.63	0.741
Structural Analysis	1.8	6.4	41.3	42.2	8.3	3.49	0.846
Energy Analysis	1.8	4.6	37.6	46.8	9.2	3.57	0.812
Lighting Analysis	1.8	3.7	37.6	47.7	9.2	3.59	0.798
Mechanical Analysis	1.8	2.8	38.5	47.7	9.2	3.60	0.784
LEED Evaluation	0.9	8.3	43.1	40.4	7.3	3.45	0.771
Code Validation	2.8	9.2	49.5	34.9	3.7	3.28	0.787
Site Utilization Planning	2.8	15.6	48.6	27.5	5.5	3.17	0.792
3D Control Planning	2.8	10.1	39.4	44.0	3.7	3.36	0.859
Digital Fabrication	1.8	17.4	46.8	31.2	2.8	3.16	0.822
Construction System Design	0.9	16.5	45.0	32.1	5.5	3.25	0.807
Record Model	0.9	5.5	29.4	55.0	9.2	3.66	0.830
Maintenance Scheduling	0.9	1.8	14.7	50.5	32.1	4.11	0.760
Building System Analysis	0.9	1.8	11.9	56.0	29.4	4.11	0.786
Asset Management	0.9	0.9	13.8	42.2	42.2	4.24	0.750
Space Management/ Tracking	0.9	1.8	16.5	45.0	35.8	4.13	0.792
Disaster Planning	2.8	0.9	20.2	49.5	26.6	3.96	0.818

Twenty-five (25) uses are listed, and revealed that 19 of the BIM uses indicated a “moderate level” with a value between 3.14 to 3.66. Meanwhile, the rest have been indicated as a “high level of awareness” with a value between 3.75 to 4.24. What stands out in the table is that the means scores of identified uses of BIM in FM practice at all stages of the project life cycle are generally average important at all stages except at the operation and maintenance phase, which is indicated as most important towards the use of BIM. This reveals that the respondents are most aware of the importance of BIM in FM practise in the operation and maintenance phase and are least aware of the importance of its use in the design and construction phase. However, they agreed that FM has an important role at the planning stage, especially in estimating and design review. This can be inferred that BIM functionalities are most used during operation and maintenance and at the planning stage.

4. Conclusions

Majority of research studies are promoting an early involvement of FM teams at decision-making stage to ensure the decision made are based upon accurate and relevant data for all project stages.This paper examines the FM organisations' awareness regarding BIM-FM integration at an early stage of the BIM process among Facility Management companies in Malaysia. Three attributes drive the awareness of BIM-FM integration in terms of the general perception, the information needed, and the function of BIM for FM.

First, this paper had evaluated an awareness of FM organisations on their understanding of information model which is Level of Development (LOD). Having good understanding and knowledge of LOD will ensure the information provided and accumulated throughout the lifespan of the building is accurate and relevant. It is apparent that from the findings of the study most of the FM organisations have a moderate awareness on LOD.

Perception of BIM-FM at the early phase of the BIM process is what the FMs believe is the potential value of the integration process into the whole life cycle phase. This survey demonstrated that facility management has a comprehensive perspective towards the integration of FM into BIM. Early involvement and full integration of BIM -FM at an early phase of the BIM process is capable of managing building information for the entire project lifecycle throughout real-time collaborative working practice with relevant and correct information data-exchange for operation phase by giving an opportunity to give feedback on decision-making in contributing long term of life-cycle cost saving of the building.

Information plays a vital role in the integration of the BIM-FM process. The inclusion of FM allows integration of information throughout the building life-cycle right from the design stage. With a low rate of knowledge and competence of the relevant information needed for the integration process, this paper has revealed that most FM organisations do not fully understand the information and documents needed for the integration process. The significance of having a clear understanding of the information and terminology of BIM-FM will help better communication with other stakeholders in BIM projects, especially for the delivery of the project information. This is consistent with the findings, which state that the skill and knowledge is a gap in defining the FM requirements for BIM process [14].

The integration of BIM into FM practice has transformed the traditional practice of FM, impacting the project information lifecycle. FM's early involvement in BIM usage across this lifecycle punctuated inputs to diverse stakeholders at various stages of a project as planning, design, construction, and operation stages. The BIM Use in FM practice provides standard terminology and structure for all stakeholders to communicate in defining the precise requirement for the integration related to process and information exchange throughout the life of the building.

The survey on the importance of BIM usage for the FM process at the early phase of BIM project practice indicated an average level in the planning, design and construction phase. However, the survey showed that BIM Use more important during the operational stage. Only a few BIM uses are rated as important at the planning stage, such as cost estimating and design review.

This is consistent with the importance of BIM Uses for the planning and design stage; which indicate that virtual collaboration between stakeholders will minimise design clashes and enhance facility management efficiency for MEP components in building projects. The final design will help the quantity surveyor to prepare the final detail cost to the client.

Meanwhile, the importance of BIM Uses at the operational stage is to ensure the building is operated according to specified design and sustainable standards. The building, structure, and equipment are well-maintained to improve building performance, reduce repairs, and reduce overall performance maintenance costs.

Overall, the study's findings suggest that the awareness of BIM-FM integration amongst facility organisations in Malaysia is still at a minimal level. Emanating from the finding is the need to acquire BIM-FM integration knowledge, skill, and practice by the FM organisations to be involved in the BIM process at the early phase.

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