Factors Affecting the Adoption of BIM-FM Integration at the Early Phase of the BIM Project

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DOI: https://dx.doi.org/10.47772/IJRISS.2024.8080363

Received: 14 August 2024; Accepted: 21 August 2024; Published: 25 September 2024

ABSTRACT

Building Information Modelling (BIM) aims to support the whole-of-life project life cycle. BIM has been practiced broadly at the design and construction stages in the Malaysian construction industry. However, it has not yet been extensively implemented in the Facility Management (FM) industry. The adoption of BIM-FM integration is complex, and the information on the adoption of BIM in the FM process is still scarce. Hence, to improve early integration of FM in BIM project, it is necessary to understand the adoption factors from various level of FM management. Thus, this research aimed to address this gap by examining the factors influencing the Facility Management Organization (FMO) in adopting the BIM-FM integration into the early phase of the BIM project. A qualitative method was adopted, and a semi-structured interview was utilised as the primary method to execute the research objective. The data were thematically analysed. The results revealed various issues influencing the BIM-FM adoption at the early phase of the BIM project. It has been concluded that there are twenty-three (23) relevant factors that contribute to the adoption BIM-FM integration. The findings of this study expected to offer better understanding to the significant factors and provide a strategy in activation the integration of BIM-FM the early BIM project in Malaysia. However, this study not considered the essential factors that contribute to the adoption process.

Keywords: BIM, Facility Management, Integration, Adoption Factor & Early Phase

INTRODUCTION

Building Information Modelling (BIM) for Facility Management (FM) is still a relatively new phenomenon. Even though BIM has been adopted and actively employed in the Architect, Engineer and Construction (AEC) industry, it hasn't been inextricably linked to FM processes. Information produced during the design and construction phases helps build operations. However, in most situations, FM teams are given unstructured and non-digital building information, which requires them to spend extra time transferring it into their FM systems. The loss of efficiency during the operations phase is caused by the discontinuity of building information. By lack of using technology will cause more risks of manual errors when it comes to keeping records and creating documents. Moreover, it requires longer and more time-consuming process and projects. Thus, the data need to interpret in a meaningful way through integrating technology with humans in cost-efficient and effective ways. Furthermore, as technology advances, buildings are becoming more sophisticated, and their operating requirements, as well as user needs and expectations, are growing more complex (Jaleel et. al, 2024).

Undoubtedly, integrating digitization and intelligent data solutions is critical to the future of FM (Bröchner et al., 2019). Numerous industry 4.0 technologies, including AI, robots, the Internet of Things (IoT), augmented reality (AR), and virtual reality (VR), have tremendous potential for FM. In all these systems, BIM stands out because it offers a collaborative environment for the early creation and coordination of building information and stores the information in a location where all project stakeholders can access it and manage it for the duration of the building lifecycle (Becerik Gerber et al., 2012; Pärn et al., 2017). As a result, one of the developments in the FM business today is the integration of FM and BIM.

For the FM, it is more important to integrate FM and BIM at the early stages of a project, particularly at the design stage, because the facility to be maintained and managed over the long term of it life cycle. Carretero-Ayuso and Garca-Sanz-Calcedo (2018) have demonstrated that failure to take maintainability intoaccount at the early design stages can result in higher life cycle, operation, and maintenance (O&M) costs.Therefore, FM involvement during the design and planning phases is needed to develop a facility withminimal O&M defects. Besides, the FM involvement in the design process stage provides the greatest opportunity to have maintenance feedback and designers' interest in assessing the facilities they previously designed.

Therefore, integrating BIM in the early stages of a project benefits the FM more than the design and construction phases; as Aldowayan and Dweri (2020) mentioned, BIM is more valuable in maintenance activities. It can improve FM efficiency by providing precise information for the built environment (Nical & Wodyski, 2016). Facility managers also view BIM as a technology that permits access to and retrieving life cycle data collected for FM employment. When they decide to use BIM, the data and information must be thorough, up-to-date, and relevant to the demands of the FM team. Information will be gathered, updated, and used throughout the project life cycle (Mohd Saidin et. al, 2024).

In Malaysia, there has been a gradual paradigm shift in increasing information communication technology (ICT) adoption and mechanisation in the FM industry. In order to get the maximum preserving accurate of the data, the needs to manage facility using BIM is essential. Thus, understanding of the benefits of FM needs to be included at the start is needed (Asworth et al.,2020). Additional as mentioned by Rashidul Islam et al, (2017), emphasis on early involvement of FM in the design stage to deliver of an efficient building which is easy and cost-effective to maintain for the occupants.

However, most FM professionals still need to perceive and quantify the advantages BIM provides to FM practice. It is apparent that a lack of understanding and awareness is one barrier to BIM adoption in FM. This is corroborated by Kong and Ho (2022), who found that the low adoption level of BIM in the Malaysian industry was caused by unfamiliarity with and a failure to comprehend and adhere to the BIM standard ISO 19650. Aside from that, BIM usage in operations and maintenance is somewhat limited because FM organizations are hesitant to engage in BIM technology. Other obstacles cited as limiting the adoption of BIM technology in FM are the shortage of BIM expertise and the absence of a strategic approach for BIM use.

Thus, this is become a main root why the adoption of BIM in the facilities management sector of the building industry in Malaysia is still in the early phase. Based on existing research, the adoption variables in a BIM demonstrated that the organization's vision, objective and core business influence the adoption process (Almuntaser et al.,2018). Researchers identified additional factors such as senior management support (Lee & Yu, 2017), high initial costs (Ahn et al., 2017), as well as employee education and training (Ullah et al., 2020) to also influence the adoption process.

BIM-FM integration at an early stage of the BIM process within the FM organisation involved an integrated process between human competency, management capability and technology to produce, process, manage

and collaborate with the innovation of the digital information. This provides the opportunity for the FM organisations to enhance their decision-making strategy by acquiring reliable information and action by the organisation unit to prepare for the decision and implementation stage. Hence, this research is expected to contribute to the recent Malaysian government initiative outlined in the Construction Industry Transformation Programme (CITP) 2020-2025 agenda to promote technology advantage throughout the construction project life cycle. The framework established in this research possibly raises awareness of BIM capabilities in improving the quality of construction projects, especially related to facilities management. The dissemination strategy for the research outcomes supports key stakeholders highlighted in the CITP agenda, such as CIDB, JKR and the likes, in evaluating the BIM uptake in Malaysia. Therefore, this paper aims to investigate the adoption factors for BIM-FM integration at an early stage of BIM process.

LITERATURE REVIEW

ADOPTION FACTORS OF BIM IN FM ORGANISATION

Early BIM-FM integration requires the organisation to reengineer its business and organisational processes. Thus, the adoption of BIM by FM organisations in the Malaysian industry depends on whether or not these organisations are interested in adopting or rejecting early BIM-FM integration. In other words, adopting BIM by FM organisations in the Malaysian industry is contingent upon these organisations' willingness to adopt early BIM-FM integration. In Malaysia, most FM companies are only appointed after the building has been completed; they have never been invited to participate in the planning and design phase of the project. Furthermore, the decision is influenced by other factors such as the external environment, the internal organisation, and the qualities of the technology itself. BIM adoption factors are the factors that can facilitate or impede the adoption of BIM in an AEC/FM industry organisation. Numerous academic inquiries (mostly questionnaire surveys) from several nations have documented the factors influencing BIM adoption as reviewed by Kim et al. (2016). Nevertheless, the impact levels of the factors influencing BIM adoption vary by country.

Ma et al. (2019) conducted interviews with Chinese BIM industry professionals to identify adoption factors. They concluded that effective project management and well-functioning software were the two essential factors driving BIM adoption. Gledson and Greenwood (2017) carried out a survey within the construction industry in the United Kingdom regarding the utilisation of 4D BIM. They discovered that BIM's relative benefit drives the adoption of 4D BIM. According to an investigation by Ahuja et al. (2016) in India into the factors influencing the adoption of BIM, the most important aspects were managerial support, trialability, and expertise. Meanwhile, Hong et al. (2016) conducted a survey in Australia to investigate the vital qualitative and quantitative factors influencing the application of BIM in small and medium-sized construction organisations (SMOs). Resultantly, the decision to embrace BIM was profoundly influenced by several elements with awareness and inventiveness being the two most important factors.

For factor classification, many researchers were found to apply a variety of typologies. According to Ma et al. (2019), the factors influencing BIM adoption can be divided into two categories: institutional factors and technology. Liao and Teo (2019) classified the elements into four categories: people, processes, technologies, and the external environment. Adoption motivation, organisational competency, and simplicity of implementation were the three groups identified by Hong et al. (2016) as the most influential factors for BIM adoption.

METHODOLOGY

An exploratory research design was adopted in this study as factors influencing BIM-FM adoption in the facility management industry for the early phase of the BIM projects have scarcely been examined.

According to Fellows and Liu (2015), the main feature of exploratory research is exploring knowledge about processes for which limited information is available. The survey strategy offers a deeper understanding and details the existence of a particular phenomenon (Gustafsson, 2017). A survey method is an investigation that offers rich information about a contemporary phenomenon in its real-world context, using data collection techniques such as interviews, questionnaires, observations, and document analysis (Yin, 2014). Furthermore, a survey strategy has been employed in various BIM-related studies (Bråthen and Moum, 2016; Gledson and Greenwood (2017); Shibeika and Harty, 2015). Previous studies have also explained the factors impacting BIM adoption in the AEC/FM industry in which quantitative approaches through questionnaire surveys were mostly utilised (Ma et el., 2019; Hong et al., 2019; Liao et al., 2019; Park et al., 2019).

In this study, an interview has been chosen as a qualitative method approach to obtain in-depth explanations from FM practitioners regarding BIM-FM integration in the early phase of the BIM project. This study aims to investigate the factors influencing the decision-making process for the adoption of early integration of BIM-FM in the FM industry. As to elicit the respondents' perceptions and ideas, the interview questions were designed to acquire a more profound knowledge of why the integration is necessary, how the FM organisation should execute the adoption process and the motivations and issues behind it. In order to prevent influencing the responses of the participants, the questions prepared were not directly based on the factors discovered in the research. The participants were asked about the factors that affected the inclusion of BIM-FM integration in the early phase of BIM projects and the opportunities and challenges associated with adopting BIM-FM in FM organisations.

Participant and Sample Size

The decision about whom or what should be sampled can benefit from the conceptualisation of Marshall and Rossman (2014). The researchers provided an example of sampling in four aspects: events, settings, actors, and artefacts. Subsequently, the sample at the site, event, process, or participant levels could be selected (Marshal et al,.2013) The estimation of the sample size is equally essential to the sampling strategy to be employed for the data collection. Dukes (1984) recommended studying 3 to 10 subjects in a phenomenon study. However, all participants must have experience with the phenomenon being reviewed. Creswell (2007) mentioned that criterion sampling is effective if all individuals studied represent people who have experienced the phenomenon.

The key FM respondents for this research were from various levels, including planning, strategy, and implementation. The participants were from different levels of FM practitioners, including top and executive management and operation-level management. The interview focused on the early adoption of BIM for FM and attempted to discover the critical adoption factors, motivations, challenges, and strategies for BIM-FM integration. During the interview sessions, the respondents were asked to think about the issues related to adopting BIM-FM integration in terms of the benefits, the barriers to company prerequisites, and the impacts of external factors.

At first, invitations for interviews were extended to 15 different respondents. However, only nine ultimately accepted the invitations and participated in the interview process. According to a previous study, the number of participants required for robust results is not definite; rather, it depends on the context and the research objective (Farrel, 2011). When dealing with a purposeful, non-random sample, the selection criteria of participants are more important than the number of interviews conducted (Wilmott, 2005). Although considerable efforts were made to maximise the number of interviews, nine interviews were considered sufficient to achieve the aim of this research. This is also in line with the suggestions by a previous study that the point of data saturation and establishing meaningful themes could be achieved with a minimum of six interviews (Ahankoob, 2018).

Interviews Procedures, Questions and Analysis

The interview questions were semi-structured and developed to elicit more detailed responses. The interviews were conducted for three months from October 2021 to December 2021. Invitations were sent to the participants via WhatsApp before the interviews, which was also employed to make initial contact with the respondents. The interview invitations contained information about the purpose of the study and the statement on confidentiality of respondents' data and information. In place of the traditional face-to-face procedure, interviews were performed through an online platform, the Google Meet software. Fifteen (15) questions were asked about BIM for FM ranging from the early adoption to the benefits and the challenges of the integration were asked to gather data concerning the integration of BIM-FM at the early phase of BIM project. The participants also asked to give their recommendations for BIM for FM implementation at the various stage from the design to operating and maintaining of the facility. Approximately, 30 to 60 minutes were spent with each person interviewed.

The researcher listened to the interview recordings several times to better understand each interview in its entirety. The goal while listening was to understand the exact meaning of what respondents were saying. This helped the author gain a profound understanding of the individual interview data and led to a more accurate transcription of the interviews. The responses to each question were then summarised and analysed for significant phrases, meanings and themes, with similar responses clustered together for analysis. The data were initially analysed by summarising the text of each interview. Subsequently, some reflection and examination of these clusters were performed which led to the main findings. The information that was obtained through the interviews was transcribed by hand. A thematic analysis of the transcribed data was performed using the NVivo software to determine the factors influencing the early adoption of BIM-FM integration during the BIM project. Thematic analysis of the collected data began with a thorough reading of each transcript. The most important phrases in the text were underlined, and words that were either relevant or matched were coded to identify themes associated with the research objective.

RESULTS AND DISCUSSION

Building Information Modelling (BIM) for FM in the Malaysian industry is still in the early implementation stage for innovative industry leaders, leaving very few practical cases and a certain lack of knowledge in academia. As a result, integration is still in its infancy and this event might affect the respondent s' ability and responses. In this study, the elements of the decision-making process framework, which are drivers, benefits or opportunities, and barriers, were identified as themes from interviews. The information gathered from the semi-structured interviews was coded using Nvivo software by developing connections between themes and respondent s' responses. The themes were represented as codes in Nvivo, whereas respondents' responses were imported as nodes. This study consisted primarily of four (4) themes: (1) the current state of FM practice, (2) the expectation of BIM-FM integration at the early stage of BIM projects, and (3) the opportunity for BIM-FM adoption at the early stage, and (4) the obstacles impeding the integration process.

A total of nine interviews were conducted among respondents consisting of top management, executive level and operation level. Five respondents did not have real BIM hand-on experience (P1, P2, P3, P4 and P7), three were aware and have knowledge of BIM, and two were unfamiliar with BIM technology. Meanwhile, P6 and P8 have been involved in BIM from the construction stage of the project. Concurrently, P5 and P9 represented management teams with an experience in BIM technology. The respondent's profiles and years of experience in their occupations are presented in Table 1.

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS |Volume VIII Issue VIII August 2024

Table 1. Profile of Respondents

Respondents Code	Role in the Organizations	Experience (Years)
P1	Facility Manager	16
P2	Senior Executive	17
P3	Head of Department	23
P4	Facility and Property Manager	20
P5	Managing Director	28
P6	Senior Executive	28
P7	Senior Manager in Facility and Operation Management	12
P8	BIM-FM Manager	12
P9	CEO	20

Factor Influencing the Adoption of BIM-FM Integration

Overall, respondents had no experience in BIM for FM in their work practice. Some respondents were classified as the industry leaders for BIM for FM, while others were considered relative newcomers. This study also revealed the requirements for the FM organisation in adopting new processes and technology. The thematic analysis confirmed a need to review current practice and situation, especially issues at the design stage and existing FM practices. Despite FM systems such as CMMS, CAFM and BMS being already used and practised in the Malaysian industry, FM work procedures were still practised manually. Five respondents stated that in their organisation, all the FM works such as work order preparation, key-in the asset list into the FM system such as CMMS, and asset tagging were manually prepared and practised and consisted in Excel format. The information for the operation and maintenance works relied on the as-built drawing provided by the contractor.

The drawings and information required by the FM for the maintenance stage were delivered after the Defect Liability Period (DLP) was issued. The data was supplied in a documented format, such as an as-built drawing, specifications and related shop drawings. Although the FM organisation already has an FM system for their practices, they are still required to manually prepare, key in, and manage all the relevant data. These processes are time-consuming and costly given the extensive data and information on FM and asset management. Some data might be incomplete, missing, or irrelevant to the operation and maintenance stage when they are keyed in manually. Thus, the FMO must re-build the data and create it again. These events contribute significantly to the inadequate flow of operation and maintenance (O&M) data, thereby increasing the cost of re-building the data.

According to Keskin et al., (2018), the data are not transferred and provided into a systematic approach once the data is delivered to the FM stage. The information is massive, scattered and not integrated into each other. The information lacked a central database where the data were not stored and kept under one system. Therefore, understanding asset and maintenance data requires a systematic and central-based approach to managing several assets, as mentioned by P2 and P6. The fragmentation of the construction process is also an issue. FM operations generally start at the middle or end stage of the project development, and most of the FM business objectives focus on the O&M stage to support the client's business operation in providing good end-users satisfaction. Thus, there are no requirements from the client for the FM team to be involved in the project delivery, especially at the planning and design stages as per Ashwoth et al., (2019).

The interviews conducted with the representatives of the FM organisation clarified the statements about integrating BIM-FM adoption of potential future BIM projects into the FM organisation policy. Most

interviewees agreed that facilities managers should be included early in project discussions. The early inclusion of the FM team is essential as it enables the designer to comprehend the design requirements for the maintenance aspects and the type of asset information that should be included in BIM for the maintenance stage. Jang (2020) asserts the importance of enhancing communication between facilities managers and other members of project teams, such as the designer and contractor. Having all the parties from the start and providing asset information contained in the BIM model to the designer and contractor is pertinent before delivering it to the design, construction and maintenance stages. The inclusion of FM teams brings new opportunities to provide a more efficient design process and advance the sustainability of the building environment, as argued by Edirisinghe et al., (2017).

The respondents also emphasised that a systematic approach is a potential benefit of implementing BIM in FM. All the building asset data from the initial stage are stored digitally. The digitalisation approach requires all the stakeholders to share and be allowed to access the information provided. Thus, the data is usable and operable automatically without human control. Besides, the data is linked with the as-built model and improve the accessibility of the data and information through electronic devices, such as mobile, tabs and others. Respondents also advocated having internet access; all the works are available and updated anytime and anywhere, especially during the pandemic. Nevertheless, one participant highlighted that for BIM-FM to be effective, all these need to fall under the umbrella of a centralised system. FM organisation needs a BIM system to receive and store assets and information safely and constantly updated.

Another vital point relayed by other participants is to consider the procurement and tendering processes in the integration of BIM-FM. As mentioned by P5, P6 and P9, the positive involvement of FM people from the start will enhance the procurement strategy of the FM contract. The relevant information for the maintenance is well-identified and will improve the tendering process in terms of pricing. Thus, using the BIM model will assist the FM team get a realistic price and accurate costing for the maintenance and operation works.

Some of the respondents felt extremely grateful that their organisation was already involved in a BIM project and gained much knowledge and experience. They discovered that BIM technology was beneficial as it speeds up the process and saves time. The data can be retrieved immediately since everything is stored in the system, which is a very convenient feature. Moreover, the data has already been entered into the model and there is no need to open any additional files. The participants can also swiftly determine the location of the assets by utilising the BIM model. They concluded that they could control time and space, thus reducing the associated cost and expenses.

The information gleaned from the interview also included the role of BIM technology in data and information management. Accordingly, respondents posited that without implementing BIM technology from the beginning, they cannot even begin to fathom how many forms or documents they will have to manage because FM practices require them to handle thousands of tools. In the project context, they realised that utilising BIM would enable them to handle such files, given that the data would be integrated into one system.

P2 and P7 acknowledged that they do not have great knowledge of BIM because they have not been exposed to the technology. Most respondents claimed that their company has never been involved in BIM projects since the core business is not engaged in construction. Hence, a lack of awareness of BIM technology is why FMOs in Malaysia are not interested in adopting BIM. P1 stated that the FM organisation has a mission, vision and awareness of IT & Technology, but the involvement in BIM at an early stage is not the priority, given that the core business focuses more on the Operational level, such as Maintenance of Building. This view was further supported by P4, who opined that the FMO would adopt BIM in operations where the core business plays a significant role, especially if the business strategy involves the construction and FM automatically. Besides, the FM also advises the client to use BIM technology. All respondents

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS |Volume VIII Issue VIII August 2024

agreed that for early involvement or BIM-FM integration, the client must demand to implement BIM technology for their assets. As suggested by P5 and P9, the FMO needs to persuade the client to participate and explore the BIM technology by articulating the benefit to their business objectives.

The analysis of the interview data revealed the FM organisation's (FMO) perceptions regarding factors influencing BIM-FM integration at the early phase of a BIM project. The factors identified from the analysis interview are summarised in Table 2.

Table 2. Factors affecting BIM-FM integration

Factors	**Comments from participants**
Top management support	Management needs to motivate the employees towards BIM technology. The management must acquire a certain level of BIM knowledge.
Business Strategy	The adoption of BIM-FM must be aligned with the company's business objectives, considering the organization's particular needs and characteristics. Core business/ FM business culture Business opportunity
Fragmentation Industry Practice	Lack of FM involvement of FM teams Never been involve in construction process
Organizational Culture	The mindset of BIM-FM integration Familiarity with new/ existing technology, workflow, or practices. Resistance to change/sceptical towards the BIM
Perceived benefits	Centralized system Manage the facilities and the operations from the start Visualisation
Perceived usefulness	Systematic process Manage documentation on an electronic device will reduce the paper use Accuracy of the data Accelerate the information retrieval
Willingness to use BIM	Implement a pilot project
BIM Awareness	Not aware of BIM-FM benefits Less exposure to BIM technology amongst employees

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS |Volume VIII Issue VIII August 2024

Training and learning for BIM- FM	Need intensive BIM-FM program
Leadership	Management level organization Lead the people with new technology
Skill and attitude	Need competent person to manage input Need team/people to manage the BIM application/system
Perception	Mentality Mind set
Client demand	Client has to explore the BIM-FM integration Has to be requested by the client
Knowledge Capability	Insufficient BIM knowledge Not involve from the start
Financial Capability	Cost of implementation High cost Price for upgrading the system
BIM complexity	BIM tools are required for up-to-date configuration Software becomes slower if too much input Requires internet connection System may be corrupted
Trialability	Application needs for trial
Accessibility	Manage the technology through mobile apps
Functionality	The information can be accessed, updated, and synchronize automatically
Technology quality	Organization's expectation of implementing BIM-FM
Procurement method	Need to look at the contract requirement.
External factor	Support from the agencies Government policies
Awareness	Awareness of new technology

CONCLUSION

BIM has gradually captured the stakeholders' interest in the Malaysian construction industry. Integrating

BIM technology into the FM brings benefits such as improved performance, increased communication and collaboration among the practitioners, increased business value for the FM organisation, and reduced cost and time management.

However, integrating the BIM-FM in the early phase of the BIM project is challenging due to various factors. A semi-structured interview was conducted to gain a depth of understanding of the BIM-FM adoption factors that influence FM organisations. This study identified the opportunities, critical challenges and driver factors of BIM integration into FM to disseminate the strategy for BIM-FM integration during the decision-making stage within FM sectors. The present findings will assist FM companies and organisations in the decision-making phase by examining the adoption criteria and the readiness of an organisation to adopt the BIM-FM integration.

Most FM industries still do not understand what BIM is and its benefits. Meanwhile, if the technical staff knows about BIM, they are unable to voice it to the top management. This analysis acknowledged a gap existed between the current FM practice. It has become clear that the current practice of FM is still not well utilised in the FM system for data and work procedures. Currently, the FM organisation must provide and re-create critical data of the FM before inputting the information manually into a digital file due to a lack of integration between the FM system, such as CMMS or CAFM systems.

Furthermore, this study highlighted the issues voiced by the FM teams regarding the lack of awareness of the design team on the potential issues regarding the maintenance phase, such as inappropriate allocation of workspace in the operational phase. The participants also claimed that getting involved in the project development was difficult because they were not invited and only appeared after the building was constructed. These events lead to the relevant information being lost or not being captured. Finally, all the necessary information is not conveyed to the Facility Manager.

Despite the abundant information about BIM, the key players in the world, especially FMO, are unaware of its benefits. This is evident in Malaysia, given that the BIM technology is still new in the Malaysian industry. The FMO are unsure of what they would gain from this technology until it is implemented. In conclusion, BIM-FM integration at the early stage of BIM projects positively impacts the FM industry. The integration is beneficial in terms of good business opportunities in the future and improvement the information performance. However, the intention to use or learn about BIM must be elucidated before an FMO attempts to implement this technology. In other words, the FMO should justify why they need to adopt or enforce BIM technology in their company.

ACKNOWLEDGMENTS

The authors would like to express her gratitude to the Ministry of Higher Education of Malaysia (MOHE) for awarding the scholarship to conduct this research, as well as to the respondents for their contributions during the interview.

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