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THE INFLUENCE OF KNOWLEDGE AND PERSUASION IN BIM-FM INTEGRATION AT THE EARLY PHASE OF A BIM PROJECT

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Abstract:

Traditionally, Facility Managers (FM) have often been handed over large numbers of files (hard and soft copies) consisting of among others drawings, specifications, operation and maintenance manuals together with product data sheets in order for them to carry out their tasks in managing facilities. This practice may indicate that information exchange between the AEC and FM phases is still fragmented. The FM phase of the construction project life cycle remains the most disconnected from the rest of the cycle. Therefore, the integration of FM at the early phase of BIM project is expected to fully engage BIM technology and bring potential significant value to assets and estates. This paper is part of a research that aims to identify the influence of knowledge and persuasion on deciding whether to adopt or reject BIM-FM integration at the early phase of BIM. Rogers' Theory of Diffusion of Innovation (DoI) has been applied to support the formation of the conceptual framework. Connecting the organisational characteristics associated with adoption innovation literature with the factors influencing the integration process (innovation characteristics, adopter characteristics, internal and external environment characteristics) brings interesting research potential that is not commonly investigated. This paper aims to have a relatively comprehensive view of the factors that can influence the adoption or rejection of BIM-FM integration at the early stage of the decision phase.

Keywords:

BIM-FM, Integration, Diffusion of Innovation, Knowledge, Persuasion

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Introduction

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 life-cycle project. With the release of 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. Thus, the application of BIM for FM is recommended in the Malaysian built environment sector to be implemented mandatorily. Therefore, the integration of FM organisation at the early phase of BIM project is expected and with the full engagement of BIM technology, it will bring a great potential to assets and estates.

However, BIM implementation into FM is still 'in its infancy' (Wijekoon, 2017) and has not reached the desired maturity level. According N.Z Che Ghani et al. (2016), building operational and maintenance costs greatly exceed its initial capital outlay for construction. Some studies suggest that for a typical facility, only 15 per cent of the lifecycle cost is attributed to the design and construction phase, while the remaining 85 per cent of the costs occur during the facility management phase (Wijekoon, 2017).

The purpose of this literature review is to analyse the current adoption of BIM in facility management. Therefore, there is a need for a further understanding of the knowledge, awareness, and decision-making process around the take-up to BIM-FM integration at the early phase project. Accordingly, this paper aims to examine the influence of knowledge and persuasion in adopting or rejecting BIM integration in FM at the early phase of BIM process.

Diffusion of Innovation

The innovation diffusion process covers decisions, activities and impacts from needs or problems (Rogers, 1983). In this process, the decision-making units strive to learn about innovation and form an attitude towards it. Observing the initial conditions that affect the innovation-decision process, Rogers (1983) gives four kinds of needs to the understanding of prior conditions, which include existing practices, the perceived needs and problems, the innovativeness, that is the degree to which an individual unit or another adoption unit is relatively incipient in adopting new ideas from other members of a system, and the social system's standards. According to Rogers (1983), needs and problems are parts of the characterization of prior conditions that may lead to the adoption of an innovation.

In the meantime, innovativeness refers to inter-individual or organization differences reacting to these new things and accounts for much of their success or failure (Goldsmith & Foxall, 2003) Innovators may welcome them and the majority may gradually adopt them, but laggards either slowly or never adopt them. Organizational innovativeness is considered as "an organization's overall innovative capability to introduce new products to the market, or open up new markets, by combining strategic orientation with innovative behaviour and process" (Catherine & Pervaiz, 2004).

The process goes through five stages (Rogers, 1983). The stage of knowledge occurs when the decision-making unit is exposed to an existing innovation and understands how it works. It includes the characteristics of the decision-making units about the socio-economic aspects, personality variables, and communication behaviour.

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Knowledge refers to members' exposure to innovation by knowledge awareness. Knowledge is established when "a person becomes aware of an innovation and has some idea of how it functions" (Rogers, 1983). This means that an adopter's character is the main indicator to measure the level of innovation knowledge.

Persuasion happens when the decision-making unit forms a favourable or unfavourable attitude towards innovation (Roger,1983). Perceived characteristics have great influence at this stage. Decision happens when the decision-making unit puts efforts in activities that lead to the choice between adopting and accepting the innovation. The third stage is attained when members decide whether "[to] engage in activities that lead to a choice to adopt or reject the innovation" (Rogers, 1983).

Concerning attitudes and the influence that knowledge and degree of persuasion have, this research paper considers contextual knowledge and attitudes discussed in previous researches. In this case, attitudes in terms of willingness to be involved in BIM expert and degree of persuasion specific to the innovation is assessed by integrating the BIM process at the early phase.

Diffusion Of Innovation (Doi) And BIM-FM Integration

Overview of DoI and BIM-FM Integration

Rogers' Diffusion of Innovations (DoI) theory is the most cited diffusion theories, with first publications appearing in 1963. The theory has been applied in the studies over 50 years, which is likely due to its simplistic can pragmatic applicability across the academic disciplines, in a review of emerging literature between 1990 and 2020.

There are three primary reasons for which the DoI theory is considered novel, original, and appropriate for this research of integrating BIM-FM at the early phase of the BIM process. Firstly, the broad range of applications across many research disciplines, including innovation diffusion, demonstrates the versatility of the theory. The theory postulates that the characteristics of the technology, the adopter, and the social system area will influential in the adoption decision [5], which makes it a particularly appealing theory in understanding what impacts FM integrated into BIM adoption. Hameed et al., 2012 and Ahmad & Kaseem, 2018, stated that the DoI theory explains the IT and BIM adoption. Other than that, there are a few studies that investigated the BIM adoption process using DoI, such as Gledson and Greewood (2017), digital innovation BIM diffusion by Shibeika and Harty (2015) and factors affecting BIM adoption by Xu et al. (2014).

Secondly, this theory presents a framework to consider the non-adoption of BIM-FM integration, which is especially important for the stakeholder who is intended to adopt BIM in their organization to prepare any actions, techniques, methodologies or steps (Khosrowsahahi and Arayici (2012), Kouch (2018). Non-adoption or rejection is an essential part of the diffusion of innovation theory and is often overlooked in the literature simply because of the bias towards successful innovations. Other than that, the diffusion of BIM in the FM, especially at the early involvement of FM teams, occurs slow rate. Both academically and for stakeholders involved in a new practice and approach in technologies needs to understand the acceptance, attitudes and reasons for the resistance in adopting BIM technology in the FM

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industry. Therefore, the Innovation-Decision Process provides a valuable framework identifying what is influencing the perceptions and attitudes towards the integration of BIM-FM in their adoption.

Thirdly, Rogers' suggests a need for theoretical contributions that apply the theory at different points in the innovation's lifetime to understand more about when innovation fails or becomes successful in its diffusion. Most of the literature on BIM adoption is developed as a framework in stages. Kouch (2018) had developed a three-step BIM implementation framework consisting of understanding, planning and piloting. He proposed the framework for the best practice of strategies, guideline and practical step in adopting BIM as planned.

According to Hochscheid & Halin, (2019b), researching the adoption factors of BIM is difficult because it depends on many different elements such as the stage of the adoption process and the dissemination process. Many studies carried out a literature review to find factors that may influence adoption but only partially view these factors. Therefore, clarifying how the knowledge and persuasion stage will influence the adoption process in BIM-FM integration at the early phase of the BIM process is needed.

Antecedents of Knowledge and Persuasion for BIM-FM integration

Knowledge in the context of BIM-FM integration in the decision-making process is related to the knowledge of the organisation towards the innovation of the technology. Hence, it is important to recognise and explore the level of knowledge towards BIM before the adoption is placed in the organisation because knowledge is a key influential factor for early decision making.

According to Innovation-Decision Process Framework, knowledge (Stage 1) is influenced by the decision-making unit characteristics. Rogers (1983) argues that the socio-economic, personality variables and communication behaviour as the important characteristics that have a significant relationship with the knowledge characteristic. The summary of the decision-making unit characteristics is presented in Table 1.

Table 1 Characteristics of Decision-Making Unit

Characteristics of Decision-Making Unit	BIM-FM Integration
Socio-economic characteristic	Awareness related to innovation and indicates the existence of knowledge and understanding of BIM based on respondents' information and experience.
Personality variables	Understanding BIM-FM integration.
Communication behaviour	Knowledge influence where they seek for information towards integration.

(Source: Author)

At the persuasion phase, an individual deepens his knowledge about technology, seeking information about its advantages or disadvantages and attributes in order to develop a favourable or unfavourable attitude toward the same.

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Rogers proposed five attributes of innovations which can affect the rate of adoption: Relative Advantage, Compatibility, Complexity, Trialability and Observability. Table 2 is a summarisation of persuasion of BIM-FM integration factors.

Table 2: Persuasion of BIM-FM Integration Factors

Innovation Characteristic	BIM-FM Integration
Relative advantage	Benefits that will be gained by the FM organisations if they are involved at the early stage of the BIM process.
Compatibility	The association of with people and organisational, legal aspects and cost of implement BIM into FM.
Complexity	BIM-FM integration is the lack of integration and interoperability between the system used throughout the building life-cycle.
Trialability	The involvement of FM at early phase and adopting new technology considered as a challenge because the FM industry is quite rigid in its approach to new technology.
Observability	Workflows due to how BIM–FM integration can improve handover process and paper-less in handling document and information that is essential to support the management of the facilities by the FM.

(Source: Author)

With respect to attitude and the influence that knowledge and degree persuasion have, this research takes into consideration contextual knowledge and attitude held by FM organizations. This includes attitude towards organizational structure and culture as well as the degree of persuasion towards the integration of BIM-FM at the early stage of BIM process.

Factors Influence The Knowledge Stage BIM-FM Integration

According to Innovation-Decision Process Framework, knowledge (stage 1) is influenced by the decision-making unit. This stage occurs when the decision-making unit is exposed to an existing innovation and understands how it works. It includes the characteristics of the decision-making units in relation to socio-economic, personality, and communication behaviour aspects. In terms of innovation's existence, there are three types of knowledge:

1. awareness-knowledge - This occurs when an organization becomes aware of an innovation and has some idea of how it functions.
2. how-to-knowledge – This is when the organization has a sufficient level of how-to-knowledge prior to the trial of the innovation.
3. principles-knowledge – This contains the functioning principles describing how and why the innovation works.

In fact, the organization may have all the necessary knowledge of BIM but this does not mean that the organization will adopt the BIM-FM integration because the organization's attitudes also shape the adoption and rejection of the integration. This research establishes the criteria of the decision-making unit characteristic that may influence the adoption of BIM-FM integration at the knowledge stage as follows:

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Socio-economic/Socio-demographic - is defined as having an awareness related to innovation. It indicates the existence of knowledge and understanding BIM according to the respondents' information and experience in terms of organizational structure, such as the years of establishment, the nature of the business, and its size.

Personality value - measures the attitude and culture of FM organizations towards BIM-FM integration in terms of level of adoption, whether the organization is part of the adoption, or non-adoption of the innovation. Other than that, the supportiveness of the organization for BIM training/courses/seminars and projected time frame to adopt BIM-FM integration by the organization that change their previous practices to new practices also influences the integration factors in BIM-FM.

Meanwhile, communication behaviour is related to how knowledge influences the organisations to seek information more actively. The questionnaires specifically refer to the awareness and understanding of what BIM-FM integration is. This is important because once the organization understands BIM-FM integration at the early phase, it can start planning the implementation by assessing its current BIM-FM integration capability. The level of awareness on BIM Level of Development (LOD) and understanding of the integration of BIM-FM aligns with the rate of competence on the information needed and the level of importance of the uses of BIM for FM process.

Factors Influence The Persuasion Stage Of BIM-FM Integration

This study intends to fill the gap in acknowledging the benefits of BIM-FM integration at the early stage of the building life-cycle process. This study identifies the potential benefits of BIM-FM integration according to the organizations' needs. This is done by ranking the list of benefits according to FM organizations' preferences. The organization's expected benefits that will be gained from the integration of BIM-FM are deemed critical in understanding the organisation's need for the development of deployment strategy in the adoption of BIM-FM integration. Before deciding to adopt innovation as their strategic organisational business, the organisation needs to analyse the tangible and intangible benefits.

The value of integrating BIM for FM resides in the inherent capabilities of BIM capturing, storing, and sharing accurate and comprehensive information about building elements and systems from pre-design to the post-construction phases (Shalbi & Turkan, 2016; Terrano et al., 2016; Hosseini, Pärn, Edwards, Papadonikolaki, & Oraee, 2018).

Thus, for this research, the questionnaire listed the expected benefits that influence the persuasion stage of FM organization in adopting BIM-FM, which are performance improvement, communication collaboration, business value, cost, and time management.

Meanwhile, understanding the characteristics of BIM-FM integration challenges is considered a cornerstone for the predictability of the adoption process because it offers constructive strategies to mitigate the challenges. The challenges surrounding BIM-FM integration are identified through literature review and the key areas for integrating BIM in FM organization from the perspectives of people/culture, processes and technology, and policy. Therefore, this research has identified the main challenges for integrating BIM-FM in FM: organizational challenges, processes and policy challenges, and technology challenges

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Research Approach For This Study

The methodology used in this study is based on the quantitative method. The research design for this study is survey research. A questionnaire survey is designed for this study according to the Innovation-Decision Process framework to meet the objectives of this study. This study 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 study is the facility management companies operating in Klang Valley and registered with CIDB under category F specialised in carrying out works for general building and infrastructure facilities (F01) as well as healthcare facilities (F02). An invitation to participate in this research was sent out to 196 organisations through email, which contained a project description and a link to the survey.

The questionnaire consists of five sections: The first section of the questionnaire is used to elicit information on the profile of the respondents; The second section is to gather information on the organisation's background and effort towards BIM adoption; and the other sections are designed to elicit information on the extent of awareness of BIM-FM integration, the potential benefits of BIM and FM integration at the early phase of the BIM project, and barriers to integrating BIM-FM. All the questions request the participants to evaluate their response according to a five-point Likert scale on the attitudinal, perception, and agreement on the 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. Therefore, the instrument of the demographic information for this study 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.

Descriptive and correlation analysis is applied to analyse the data from the questionnaire finding with Statistical Package for Social Science (SPSS). Descriptive analysis statistics such as frequency, percentage, and relative index/mean rating described using tables, charts, and figures. Ultimately, the patterns that emerged from the data analysis could be translated in a more meaningful way. Spearman correlation analysis is employed for this parametric procedure, examining the association and linear relationship between BIM-FM awareness, perceived benefits and challenges of integration BIM-FM at the early phase of the BIM process.

It starts with an analysis of the respondents' profiles and organization demographic. The respondents' profiles are specifically assessed based on their years of experience in the current organization, level of awareness, and general knowledge of the BIM industry.

Meanwhile, the organizational background consists of two types of information that need to be analysed. The first analysis is on the organizational structure related to the nature of their organizations' business. The second criteria are on the organization behaviour towards BIM technology.

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For the BIM-FM integration profiles, they are evaluated on their awareness of BIM-FM integration at the early phase of the BIM process based on their organization'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. They are then followed by the organization's perception of the possible benefits of the integration of BIM-FM at the early phase of the BIM process. Lastly, the analysis will analyse the barriers that impeding the FM organization in integrating the BIM-FM.

In order to understand how the FM organisation can positively employ the BIM-FM integration process, it is necessary to establish how the organisation prepared, planned and reorganised its strategy to adopt the integration later on.

Conclusion

The research presented in this paper demonstrates that Rogers' Diffusion of Innovation theory provides a deep understanding of the influence of knowledge and persuasion on the decision-making stage. The integration of FM into BIM at the early phase of BIM has been referred to as innovation, and decision-making characteristics should be the key elements. Therefore, this research explores the theoretical requirements to the factors that affect BIM-FM integration characteristics such as BIM-FM characteristic (innovation attribute) and organisation's internal and external characteristics (organisational awareness) on the BIM-FM integration to enhance awareness on early involvement of FM teams in the BIM projects. Technically, the awareness of BIM in the FM industry must be arising in the organization at the early stage for rapid adoption of BIM as reported in the National BIM Report 2016 where knowledge on BIM is still minimal despite the awareness of BIM in the construction industry. Slow adoption of BIM in the FM industry might also relate to the awareness, perception of usefulness, and compatibility with the new technology (BIM) and also the fear of changes by users. It is pertinent to note that detail discussion of the survey results will be made in a future paper.

References

Ahmed, A.L., & Kaseem, M. (2018). A unified BIM Adoption Taxonomy: Conceptual Development, Empirical Validation and Application. *Automation in Construction*, (96), 103–127.

Che-Ghani, N.Z.; Myeda, N.E.; Ali, A.S. (2016), Operations and Maintenance Cost for Stratified Buildings: A Critical Review. *MATEC Web Conference*, 66, 00041.

CIDB Malaysia. (2015). Construction Industry Transformation Programme 2016-2020. http://doi.org/10.1007/s13398-0173-7.2

CIDB Malaysia. (2016). BIM Guide Malaysia. Retrieved January 12, 2021, http://www.bimcentre.com.my/bim-guide/

Gledson, B. J., & Greenwood, D. (2017). The Adoption of 4D BIM in The UK Construction Industry: An Innovation Diffusion Approach. E*ngineering Construction and Architectural Management*, 24(6), 950–967.

Goldsmith, R. E., and G.R.Foxall. (2003). The Measurement of Innovativeness, In L.V. Shavinina (Ed.), *The International Handbook of innovation. Oxford: Elsevier Ltd*, 8, pp.321.

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JISTM
EISSN: 0128-1666
Volume 6 Issue 24 (December 2021) PP. 70-78
DOI: 10.35631/JISTM.624007

Hameed, M. A., Counsell, S., & Swift, S. (2012). A Conceptual Model For the Process of IT Innovation Adoption in Organizations. *Journal of Engineering and Technology Management*, 29(3), 358–390.

Hochscheid, E., & Halin, G. (2019). A Framework For Studying the Factors That Influence the BIM Adoption Process. *In 36th CIB W78, ICT in Design, Construction and Management in Architecture, Engineering, Construction and Operations. Newcastle*

Hosseini, R., Pärn, E., Edwards, D., Papadonikolaki, E., & Oraee, M. (2018). Roadmap to Mature BIM Use in Australian SMEs: *Competitive Dynamics Perspective. Journal of Management in Engineering*, 34(5), 05018008.

Khosrowshahi, F., & Arayici, Y. (2012). Roadmap for implementation of BIM in the UK construction industry. *Engineering, Construction and Architectural Management*, 19(6), 610–635.

Kouch, A. M. (2018). A three-step BIM implementation framework for the SME contractors. In C. Fortin, L. Rivest, A. Bernard, & A. Bouras (Eds.), *IFIP Advances in Information and Communication Technology: Vol. 540. Product Life Cycle Management to Support Industry 4.0*, 15–24.

Krejcie,V.R., & Morgan.W.D., (1970). Determining Sample Size for Research Activities, Educational and Psychological Measurement, (30), Duluth: University of Minnesota

Rogers, E. M. (1983). Diffusion of innovations (3rd ed.). Free Press.

Shalabi, Y. Turkan. (2016). IFC BIM-based facility management approach to optimize data collection for corrective maintenance, *Journal of Performance of Constructed Facilities,* 31(1), 04016081.

Shibeika, A., & Harty, C. (2015). Diffusion of digital innovation in construction: a case study of a UK engineering firm diffusion of digital innovation in construction: a case study of a UK engineering firm. *Construction Management and Economics*, 33(5–6), 453–466.

Terano,S., Edirisinghe,R,. Anumba,C. (2019). The Influence of Managerial Strategy On The Implementation of BIM in Facilities Management: A Case Study. *36th CIB W78, 2019, Conference Advance in ICT, Design Construction and Management in Architecture, Engineering, Construction and Operation*. pp 455-464

Wang L. Catherine and Pervaiz K. Ahmad. ((2004). The development and validation of the organizational innovativeness construct using confirmatory factor analysis, *European Journal of Innovation Management*, 7(4), 303-313.

Wijekoon, Christaline & Manewa, Anupa & Ross, Andrew. (2018). Enhancing the Value of Facilities Information Management (FIM) Through BIM Integration. *Engineering, Construction and Architectural Management.* 27(4), 809-824.

Xu, H., Feng, J., & Li, S. (2014). Users-orientated Evaluation of Building Information Model in the Chinese Construction Industry. *Automation in Construction*, (39), 32–46.