THE ADOPTION OF BUSINESS INTELLIGENCE BIM SYSTEM IN CONSTRUCTION: A STUDY OF READINESS IN MALAYSIA

Janice Ang Yizing
Graduate School of Business, Universiti Sains Malaysia, 11800 USM Pulau Pinang, Malaysia
Sima Ahmadpour*
Graduate School of Business, Universiti Sains Malaysia, 11800 USM Pulau Pinang, Malaysia
E-mail: ahmadpour.sima@usm.my
Joshua Teck Khun Loo
UOW Malaysia University College, Penang, Malaysia
Leila Ahmadpour
LUISS University, department of management, Rome, Italy
E-mail: lahmadpour@luiss.it

Abstract

Many researches had covered the advantages and challenges of BIM system in construction industry, but few research is focusing on the readiness of Malaysia in adopting the system. This study examines the construction individuals' readiness of adopting building information modelling (BIM) system in Malaysia. To further address this, this research target to identify the factors of affecting the readiness of adopting BIM system and to identify what is the upcoming steps to be done to enhance the readiness level. The research was conducted in Malaysia with the contribution of different individuals in construction industry including architect, engineer, quantity surveyor, contractor and developer. A total number of 350 questionnaires were completed and a total of 343 data was analyzed by structural equation modelling (SEM) method using Smart-PLS software. Results showed that construction in Malaysia has positive readiness to adopt BIM system in the aspect of facilitating conditions, effort expectancy and social influence whereas further support is required in terms of performance expectancy where the industry need to work in tandem with the authority and regulatory bodiesto develop programmes and initiativesto fully improve the readiness of individuals in construction.

Keywords: Building Information Modeling (BIM), Construction, UTAUT

Introduction

The construction industry is a less digitized industry compared with other industries such as the automation, manufacturing, semiconductor and telecommunication industry. The innovation, productivity and adoption of digital tools in construction industry in general has lagged (Bughin, Manyika, & Woetzel, 2017). Besides, inadequate digital proficiency and lack of technology adoption in the construction industry also affects the inefficiency in project costs, delay of project progress, poor decision making and productivity (Nikas, Poulymenakou, & Kriaris, 2007). The utilization of BI in construction management processes empowers companies to drive revenue, reduce costs, and consequently increase profits (Azma & Mostafapour, 2012). Strategic decision processes involve rationality and intuition (Golestanizadeh, Sarvari, Chan, & Banaitiene, 2023). While intuitive methods based on experience and professional knowledge contribute to project success and performance (Abubakar, Elrehail, Alatailat, & Elçi, 2018). BI enables project managers to leverage all available capabilities, converting them into a vast set of information and knowledge for a competitive industry advantage (Hashemi, Hamzah, Jansri, & Ahmadpour, 2025) (Djatna &

Munichputranto, 2015). Furthermore, intuition positively impacts decision outcomes in unstable decision environments but has a negative effect in stable decision environments (Kowalczyk & Buxmann, 2015).

Decision-making remains an ongoing and crucial aspect of large and intricate projects (Abu AlSondos, 2023) (Songjin, Ahmadpour, Loo, & Hashemi, 2024). One of the primary benefits of BI is its ability to construct dynamic, organic, agile, and adaptable structures in the smallest amount of time necessary to comprehend and react to environmental changes (Muntean & Surcel, 2013). Due to the growing number of construction projects, construction project managers require a variety of business intelligence tools to identify critical metrics, analyze different project aspects, evaluate opportunities and challenges, and examine long-term plans and decisions to maximize project success and return (Abioye, et al., 2021). This is despite BI being crucial as a foundation for development and competitive advantage in the management of construction projects and companies (Golestanizadeh, Sarvari, Chan, & Banaitiene, 2023). The data that can be obtained from BIM allow building owner to make fast and correct decision based on the information obtained from the model. According to the Construction Industry Development Board (CIDB) BIM report in 2021, Malaysia's adoption rate of BIM is recorded at 55% which is lower than developed countries such as United States at 80% while United Kingdom at 73% (Basir, 2023). This study provides a research opportunity to investigate the readiness of the adoption of business intelligence system in construction industry in Malaysia.

Literature Review

1. Business Intelligence System

Business Intelligence (BI) is a comprehensive term encompassing various technologies, applications, and processes designed for the collection, storage, access, and analysis of data, with the overarching goal of assisting users in making informed and improved decisions (Wixom & Watson, 2010). BI encompasses a broader scope, involving the collection of data from source systems, its storage, and the subsequent access and analysis of the data through BI technologies and applications (Foley & Guillemette, 2010). In essence, BI covers both the processes of acquiring data into a warehouse and retrieving data by utilizing technologies or applications that serve specific business purposes (Khan & Quadri, 2012). On one end of the spectrum, some organizations may have a limited commitment, employing a few data marts with applications serving very specific but crucial purposes (Ballard, Gupta, Krishnan, Pessoa, & Stephan, 2005). Conversely, at the other extreme, some organizations make substantial investments, dedicating multi-million dollars to establish enterprise data warehouses (Wixom & Watson, 2010). According to the Construction Industry Development Board (CIDB) BIM report in 2021, Malaysia's adoption rate of BIM is recorded at 55% which is lower than developed countries such as United States at 80% while United Kingdom at 73% (Basir, 2023). In a few studies from 2019 to recent, there were studies related to challenges of adopting BIM system in Malaysia for contractors stated that cost is the main challenge, followed by system required, lack of knowledge and lastly readiness to change (Ismail, Zulkifli, Baharuddin, Ismail, & Mustapha, 2022). In our studies, we will be focusing on investigating the readiness of BIM adoption in construction in Malaysia.

Theories and Hypotheses Development

This study investigates the readiness of BI adoption in construction individuals. A few numbers of acceptance models and theory that are suitable for this research were done through the conceptual study and the research literature. Through the literature review, it was found

that there are four models related to technology adoption have been proposed. The models include theory of reasoned action (TRA) (Fishbein & Ajzen, 1975) and its successor model theory of planned behaviour (TPB) (Ajzen, 1985). This study will focus on UTAUT model.

1. The Unified Theory of Acceptance and Use of Technology (UTAUT)

An integrated theory of technology acceptance which is also known as the unified theory of acceptance and use of technology (UTAUT). UTAUT studied the human acceptance behaviour across a range of disciplines (Venkatesh, Morris, Davis, & Davis, 2003). Subsequently, this model was utilized in this study. The model, which is depicted in Figure 1, includes performance expectancy, effort expectancy, social impact and facilitating conditions as the components influencing the preparedness for BI adoption. The related hypotheses are described as follows. The variables that were investigated as determinants of readiness were performance expectancy, social influence, effort expectancy, and facilitating condition. As most investigations just utilized a subset of the UTAUT model, and mediators were regularly ignored (Dwivedi, Rana, Jeyaraj, Clement, & Williams, 2019). It was referenced that past research might not have utilized the moderators since there may not be any distinction in the adoption readiness and usage context. The altered version of the model is introduced in figure below.

2. Conceptual Framework

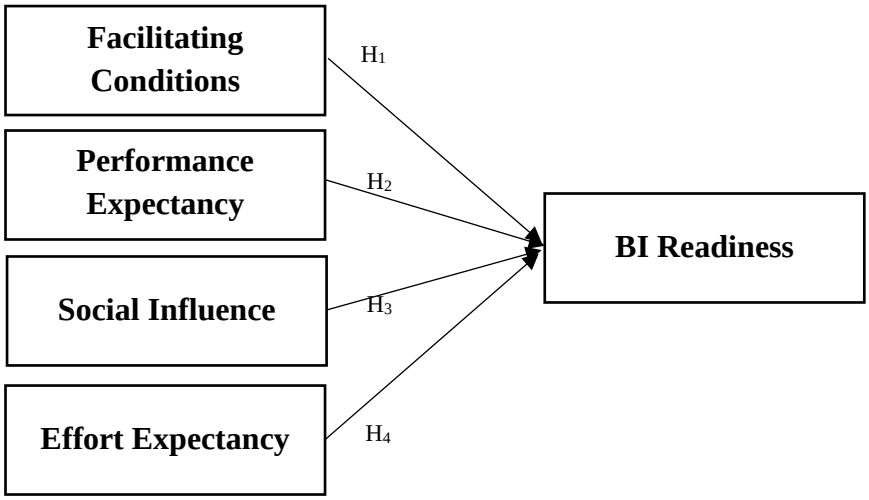

Figure 1: Conceptual framework

3. Facilitating conditions

Facilitating conditions is one the factor to evaluate BI readiness. Having the awareness of the advantage and importance of BI adoption is insufficient. Individuals or organization in construction industry require to have a strategic vision, planning and adoption plan to ensure the BI adoption can be carried out successfully within the designed timeframe. Besides from having a vision, planning and standard of procedures, it is also utmost important to have consultations from the experts (Yeoh & Koronios, 2010) (Horani, et al., 2023)(Boonsiritomachai, McGrath, & Burgess, 2016).

Hypothesis 1: Existing infrastructure will have positive impact towards BI readiness

for construction in Malaysia

4. Performance expectancy

Performance expectancy is considered as one of the factor in evaluating the readiness of BI adoption for construction in Malaysia. It is known as the extend of an individual trusts the adoption of the system will aid in work performance. Performance prospect plays a preponderant role in BI readiness in an industry including recognising and acknowledging its perceived benefit, the complexity of the system and its compatibility with the workflows. (Owusu, Ghanbari-Baghestan, & Kalantari, 2017) (Ramírez-Correa, Grandón, & Ramírez-Santana, 2019) (Andavara, Sundaram, Bacha, Dadi, & Karthika, 2021.

Hypothesis 2: Performance expectancy will have positive impact towards BI readiness for construction in Malaysia.

5. Social influence

Supportive team and ample resources are thought to be the key components towards BI readiness. Education, dedication, satisfaction, support, and partnership as the elements determining the preparedness and success of BI (Anjariny, Zeki, & Hussin, 2012) (Popovič, Hackney, Coelho, & Jaklič, 2012) are striving to adopt the latest and most advanced BI system to ensure they are on par as their competitors (Wang & Wang, 2016) (Loo, Leong, Siew, & Ahmadpour, 2024).

Hypothesis 3: Social influence will have positive impact towards BI readiness for construction in Malaysia.

6. Effort expectancy

Effort expectancy is one of the factors towards BI readiness. Having the awareness of the advantage and importance of BI adoption is insufficient. It is required to have a strategic vision, planning and adoption plan to ensure the BI adoption can be carried out successfully within the designed timeframe (Williams & Williams, 2007). Besides from having a vision, planning and standard of procedures, it is also utmost important to have consultations from the experts (Yeoh & Koronios, 2010) (Eckerson, 2022).

Hypothesis 4: Effort expectancy will have positive impact towards BI readiness for construction in Malaysia.

Discussion

This study model findings revealed the readiness of BI system adoption in Malaysia construction, particularly for BIM system. Social impact indicates that Malaysia construction individuals has a positive relationship between social influence and BIM system adoption. This shows that the construction industry in Malaysia has a healthy competition environment in BI system adoption and it is completely ready for the adoption of BIM system. The adoption of BI system between competitors will affect an organization to be on par as the competitors.

Facilitating conditions aspect indicates that the Malaysia construction individuals are ready in terms of facilitating conditions and it has a positive impact towards BIM system adoption. This shows that a lot of financial and resources support ranging from the high management to the employee level has been given in the adoption of BI system to ensure its success (Eckerson, 2022).

The effort expectancy on the system adoption suggesting that the effort prospect has a positive impact towards BI system adoption in Malaysia construction and the readiness in adopting BIM system is high. This show that the Malaysia construction industry is putting a

myriad of effort in adopting BI system which includes crafting a BIM execution plan, constant review of the progress and performance of system implementation, constant update and improvising the work flow and also educating all the stakeholders in operating the system to ensure all the stakeholders has the ability to access the data (Messner, et al., 2019).

References:

Abioye, S. O., Oyedele, L. O., Akanbi, L., Ajayi, A., Delgado, J. M., Bilal, M., Ahmed, A. (2021). Artificial intelligence in the construction industry: A reivew of present status, opportunities and future challenges. Journal of Building Engineering, 103299.

Abubakar, A., Elrehail, H., Alatailat, M., & Elçi, A. (2018). Knowledge manangement, decision making style and organizational performance. Journal of Innovation & Knowledge, 1-15.

Ajzen, I. (1985). From intention to actions: A theory of planned behaviour. Springer Verlag. Davis, F. (1986). A technology acceptance model for empirically testing new end-user infomation.

Andavara, V., Sundaram, B., Bacha, D., Dadi, T., & Karthika, P. (2021). The impact of perceived ease of use on intention to use mobile payment services for data security applications.

Anjariny, A. H., Zeki, A., & Hussin, H. (2012). Assessing organizations readiness toward business intelligence systems: A proposed hypothesized model. Advanced Computer Science Applications and Technologies (ACSAT), 2012 International Conference, (pp. 213-218).

Azma, F., & Mostafapour, M. A. (2012). Business intelligence as a key strategy for development organizations. Procedia Technology, 102-106.

Ballard, C., Gupta, A., Krishnan, V., Pessoa, N., & Stephan, O. (2005). Data mart consolidation: Getting control of your enterprise information. United States: International Business Machines Corporation.

Basir, E. K. (2023). BIM adoption for a boost for construction post-pandemic. Malaysia: Bernama.

Boonsiritomachai, W., McGrath, G., & Burgess, S. (2016). Exploring business intelligence and its depth of maturity in Thai SMEs. Cogent Business & Management.

Bughin, J., Manyika, J., & Woetzel, J. (2017). Reinventing construction: a route to higher productivity. Mckinsey Global Institute.

Djatna, T., & Munichputranto, F. (2015). An analysis and design of mobile business intelligence system for productivity measurement and evaluation in tire curing production line. Procedia Manufacturing, 438-444.

Dwivedi, Y., Rana, N., Jeyaraj, A., Clement, M., & Williams, M. (2019). Re-examining the unified theory of acceptance and use of technology (UTAUT): Towards a revised theoritical model. Information Systems Frontiers, 719-734.

Eckerson, W. (2022). The decision support sweet spot. Journal of Data Warehousing, 4-9.

Fishbein, M., & Ajzen, I. (1975). Belief, attitude, intention and behaviour: An introduction to theory and research. Addison-Wesley.

Foley, E., & Guillemette, M. G. (2010). What is business intelligence? International Journal of Business Intelligence Research, 1-28.

Golestanizadeh, M., Sarvari, H., Chan, D. W., & Banaitiene, N. (2023). Opportunities in application of business intelligence in construction companies. Journal of Civil Engineering and Management, 487-500.

Hashemi, S., Hamzah, H., Jansri, W., & Ahmadpour, S. (2025). Local Community Involvement in Sustainability Tourism Development in Malaysia: A conceptual model. Environment-Behaviour Proceedings Journal, 10(SI 25).

Horani, O. M., Al-Adwan, A. S., Yaseen, H., Hmoud, H., Al-Rahmi, W. M., & Alkhalifah, A. (2023). The critical determinants impacting artificial intelligence adoption at the organizational level. Information Development.

Ismail, N. A., Zulkifli, M. A., Baharuddin, H. A., Ismail, W. W., & Mustapha, A. A. (2022). Challenges of adopting building informaition modelling (BIM) technology amongst SME's contractors in Malaysia. IOP Conference Series: Earth and Environmental Science (p.012047). IOP Publishing.

Khan, R. A., & Quadri, S. K. (2012). Business intelligence: An integrated approach. Business Intelligence Journal, 64-70.

Kowalczyk, M., & Buxmann, P. (2015). Perspectives on collaboration procedures and politics during the support of decision processes with business intelligence & analytics. ECIS 2015 Completed Research Papers, 109.

Loo, J. T. K., Leong, C. L. P., Siew, M. L., & Ahmadpour, S. (2024). Determinants of students' intention of choice to study at higher education institutions of Malaysia in the COVID-19 era. International Journal of Management in Education, 18(5), 481-514.

Messner, J., Anumba, C., Dubler, C., Goodman, S., Kasprzak, C., Kreider, R., . . . Zikic, N. (2019). BIM project execution planning guide - Version 2.2. Pennsylvania: Penn State University.

Muntean, M., & Surcel, T. (2013). Agile BI - The future of BI. Informatica Economica, 114-124.

Nikas, A., Poulymenakou, A., & Kriaris, P. (2007). Investigating antecedents and drivers affecting the adoption of collaboration technologies in the construction industry. Automation in Construction, 632-641.

Owusu, A., Ghanbari-Baghestan, A., & Kalantari, A. (2017). Investigating the factors affecting business intelligence systems adoption: A case study of private universities in Malaysia. International Journal of Technology Diffusion, 25.

Popovič, A., Hackney, R., Coelho, P. S., & Jaklič, J. (2012). Towards business intelligence systems success: Effects of maturity and culture on analytical decision making. Decision Support Systems, 729-739.

Ramírez-Correa, P., Grandón, E., & Ramírez-Santana, M. (2019). Explaining the use of social network sites as seen by older adults: The enjoyment component of hedonic information system. International Journal of Environmental Research and Public Health, 11.

Songjin, S., Ahmadpour, S., Loo, J. T. K., & Hashemi, S. (2024). Determinants Influencing Consumer Repurchase Intention on IoT Products: Moderating Effects of Brand Image. Global Business and Management Research, 16(4), 95-118.

United States: Sloan School of Management, Massachusetts Institute of Technology.

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. MIS Quarterly, 425-478.

Wang, Y.-M., & Wang, Y.-C. (2016). Determinants of firms' knowledge management system implementation: An empirical study. Computers in Human Behavior, 829-842.

Williams, S., & Williams, N. (2007). The profit impact of business intelligence. San Francisco: Morgan Kaufmann Publishers.

Wixom, B., & Watson, H. (2010). The BI-based organization. International Journal of Business Intelligence, 16.

Yeoh, W., & Koronios, A. (2010). Critical success factors for business intelligence systems. Journal of computer information systems, 23-32.