ASSESSING THE EFFECTIVENESS OF BIM IMPLEMENTATION IN ENHANCING CLIENT VALUE IN DEVELOPMENT PROJECTS

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(Received 27th October 2025; revised 23rd January 2026; accepted 04th February 2026)

Abstract. The concept of Building Information Modelling (BIM) has revolutionised the construction industry in Malaysia, especially in the project delivery aspect of the sector, by promoting collaboration and delivering better results for clients. This paper examines the effects of BIM on client projects as perceived by consultants in the Klang Valley. It focuses on aligning BIM with client expectations, the challenges of standardising deliverables, and the strategic importance of BIM in project delivery. A quantitative design was used, with a structured questionnaire administered to 167 consultants. The data analysis was conducted using IBM SPSS software, which included BIM adoption, project impacts, implementation barriers, policy influence, and future trends. The results indicate that BIM enhances communication, stakeholder interaction, and transparency of costs and design accuracy, which positively affect client satisfaction, but issues such as high costs, a lack of skills, and change resistance persist. The research paper concludes that BIM offers advantages for clients but requires support from government policies, standardisation, and capacity building to expand its use and enhance its long-term value in real estate development.
Keywords: *Building Information Modelling, clients value, quantitative method, project delivery*

Introduction

The history of the development of digital construction methods is marked by a radical shift in how architecture and engineering work, driven mainly by advances in computer technology and software development. Digital methodologies can be traced back to the 1960s, when Computer-Aided Design (CAD) systems were developed, enabling geometric modelling and jump-starting future developments in Building Information Modelling (BIM). BIM was a major development that surpassed traditional CAD, as it was not only a drafting tool but also a lifecycle information-generation, sharing, and management system (Nawari and Kuenstle, 2015). As CAD was replaced by BIM, the construction industry witnessed a paradigm shift, with the two-dimensional (2D) representation giving way to a three-dimensional (3D) digital representation capable of storing detailed information about the building's physical and functional properties. The BIM system provided an opportunity to incorporate data into its system, enabling a collaborative strategy among stakeholders and facilitating mutual understanding and communication in both the design and construction processes (Ali et al., 2018). The concept of BIM covers all geometry parameters, material specifications, cost information, and lifecycle management, which guide decisions throughout the design and into facility management (Di Giovanni et al., 2024). The technological and cultural changes that have permeated the sources of BIM development are moving the industry toward integrated, data-driven decision-making processes that are likely to deliver greater performance and sustainability. A solid grasp of such a shift not only enriches the current debate surrounding digital building but also enables future innovations that optimise building lifecycle management (Poljanšek, 2017). The

eISSN: 2716-6481
https://doi.org/10.55197/qjssh.v7i1.1089

professional, be it an Architect, a Quantity Surveyor, or an engineer, who applies BIM to the client project makes a significant positive contribution to the project.

Quantity take-off and cost estimation (5D BIM)

The incorporation of 5D Building Information Modelling (BIM) in construction projects has transformed the process of handling quantity take-offs (QTOs) and cost estimates. This computer-aided method increases the accuracy of financial planning, project budgeting, and resource allocation, as 5D BIM can be used at early phases of construction and simplifies workflows while minimising the risk of errors and cost overruns, since cost (and time, respectively) dimensions are embedded in 5D BIM. 5D BIM is of great benefit to the quantity surveying practices. The use of a five-dimensional cost model, as described by Succar (2010), enables full-fledged, precise design evaluations, and project teams can obtain quantities and develop cost estimates using a relational, parametric model. Such capabilities are especially advantageous because they enable the quantity surveyors to use real-time data to make better decisions. The 5D BIM dynamism helps track project cost-programmed budgetary allocations through model parts connected to cost databases, synchronising the estimative procedures with the real project development (Howard and Björk, 2008). The development of BIM applications in the construction industry is shown in *Figure 1*.

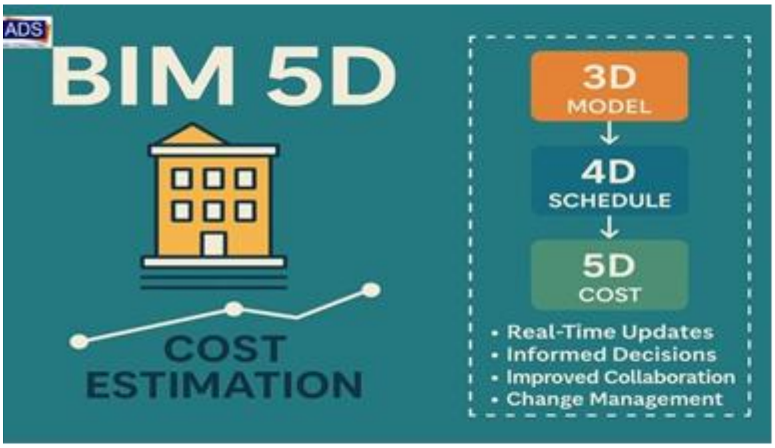

Figure 1. *Building Information Modelling (BIM).*

In addition, comparing the results of manual and automated extraction of quantities in 5D BIM shows a significant improvement in efficiency. 5D BIM can only be successfully integrated when there is close cooperation between modelling, time planning, and cost estimating specialists, as the different facets of BIM are interdependent (Bryde et al., 2013). The teamwork atmosphere created by 5D BIM enables timely changes to the project scope in line with quantitative information, consumer needs, and market fluctuations. It also enhances cost estimation capabilities by introducing machine learning into BIM applications. Linear regression and neural network methods can be implemented in BIM settings to help identify and classify objects, as well as to generate effective data for Quantity Take Off and cost analysis (Farouk et al., 2023). This technological development not only increases accuracy but also enhances predictive power, enabling more strategic financial planning. Moreover, the strategic use of 5D BIM for cost management highlights its essential role in integrated project delivery strategies. 5D BIM reduces the risks associated with

eISSN: 2716-6481
https://doi.org/10.55197/qjssh.v7i1.1089

financial mismanagement by providing a global perspective on project costs. A governance structure intended to reduce cost overruns through 5D BIM integration (Farouk et al., 2023). Their results point to the effectiveness of systematically introducing this technology to facilitate efficient project delivery, particularly in highly complex projects such as rail construction. Along with its pros, the 5D BIM implementation is not free of challenges. Problems may include poor training, resistance to change, and cultural barriers that hamper successful adoption. Altaf expounds on all these issues whilst adding that using the Quantity Surveyors' 5D BIM technologies can improve estimating skills and better manage project costs (Farouk et al., 2023; Steel et al., 2012).

The adoption rate of 5D BIM technology is also evident worldwide, with its use becoming more notable in nations such as the United States and Europe. This trend is supported by the narrative provided by Nawari and Kuenstle (2015), which shows that it is mostly adopted in major projects where planning is the key factor (Mohammed and Hilal, 2024). To sum it up, the introduction of 5D BIM offers considerable benefits in improving the quality of quantity take-off and cost estimation procedures, thereby ensuring better project management outcomes for clients in the construction industry.

The impact of BIM application on the clients project

Improvement in project delivery time

A close association between efficient BIM and project delivery performance, especially in minimising project duration. The study's findings demonstrate that communication among project stakeholders, supported by BIM, is a key factor in maintaining momentum during construction. Having the entire project lifecycle visualised in a centralised model enables teams to anticipate potential threats and address them early, reducing delays.

Enhancement in quality and risk management

The concept of building information modelling (BIM) has had a significant impact on project performance in the construction industry, particularly in improving quality and risk management. This is made possible by BIM integration, which can facilitate better planning, visualisation, and risk management across the different stages of construction projects, resulting in higher quality and fewer errors. Among the main advantages of BIM is its ability to provide comprehensive risk management throughout a project's life cycle. As emphasised in Numan (2024) as well as Bryde et al. (2013), BIM enables the use of smart 3D to combine comprehensive project data, enabling the identification, analysis, and mitigation of potential risks. This enables proactive management of potential pitfalls, allowing project teams to overcome issues before they become major problems. For example, BIM-generated visualisations can be used to predict construction disputes and conflicts that may undermine the project's quality.

Client satisfaction and value creation

The implementation of Building Information Modelling (BIM) has profound implications for client satisfaction and value creation in construction projects. As a transformative technology, BIM not only enhances the quality of project delivery but also fosters deeper client engagement, ultimately leading to increased satisfaction and perceived value. Additionally, service delivery elements such as compliance with client briefs, communication, and collaboration are technical determinants of client satisfaction (Steel et al., 2012). The research concludes that efficient management practices contribute to higher levels of client satisfaction, reinforcing the idea that perceived service quality is integral to achieving value in construction outcomes.

Materials and Methods

The chosen approach is the most effective for achieving the research aims and objectives. A questionnaire survey explains the distribution method and the study's target group, the responders. The quantitative research approach was chosen for this study because it requires a survey of perceptions and opinions from individuals or populations with experience and knowledge in the research area to produce findings (Ali et al., 2018). Given the limited scope of the BIM research area and the clients project, this approach was deemed appropriate. Quantitative research processes help achieve study objectives by gathering diverse data and information from specified respondents. This would expand the scope of this research study, making implementation more feasible.

Sampling method

The sampling method is a technique for selecting a population that requires defining the population's categories and characteristics before selecting the intended respondents. Creswell (2021) believes sampling is a pre-established strategy for obtaining a sample from a designated population before data collection. The research study employs non-probability quota sampling to identify respondents, as it necessitates a specific consultant with experience in clients projects that have either implemented BIM or do not utilise BIM as a construction practice. The quota sampling strategy would effectively reduce the number of respondents without encompassing the entire population of consultants in the Klang Valley, as this would be unfeasible for the research project. Additionally, an estimated 765 consultants, including Architects, Engineers, Quantity Surveyors, and others, are listed in the Klang Valley area. To achieve this research study, the targeted audience will need 201 respondents, a 5 per cent margin of error and a 90 per cent confidence level as calculated by the Raosoft sample size calculator (*Figure 2*). However, 16 per cent of the questionnaires are expected to be returned to the researcher, leading to a total of 167 respondents to this study.

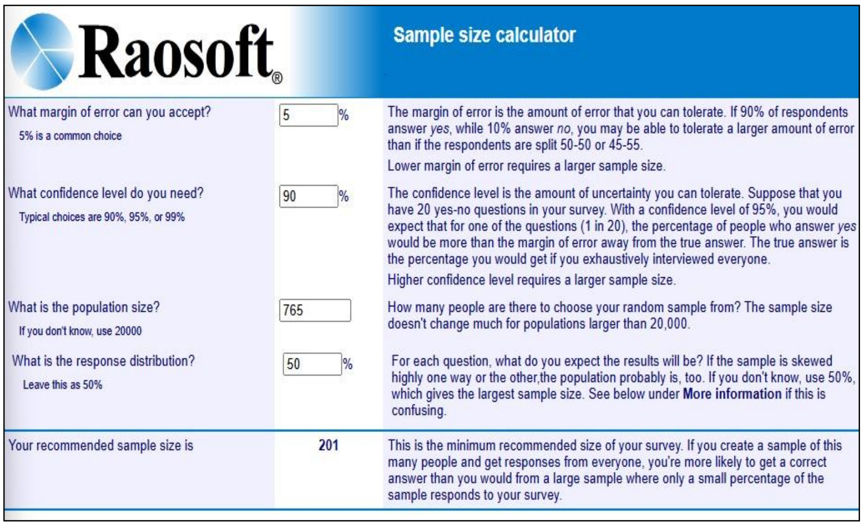

Figure 2. *Sample size calculator.*

Questionnaire instrument

The questionnaire survey will include six (6) major sections, aligned with the research objectives, to investigate the effects of Building Information Modelling (BIM) applications on client project outcomes and the limitations or challenges consultants face in aligning BIM practices with client objectives. This will consist of thirty-two (32) sets of questions based on the respective groups, and in this case, this aligns with the purpose of the research as presented in *Table 1*.

Table 1*. Sets of questions in questionnaire instrument.*

Section	Title	Number of question
A	Demographic Information	4
B	Adoption and Implementation of Building; Information Modelling (BIM)	3
C	Impacts of Building Information Modelling (BIM) on Clients' Projects	7
D	Building Information Modelling (BIM) Challenges and Barriers	7
E	CIDB Policies for BIM Adoption	7
F	Future of BIM in Construction	4
	Total number of questions in the survey	32

Results and Discussion

Respondents profession

Most of the respondents were Engineers (32.3%), Architects (29.3%), and Quantity Surveyors (20.4%) (*Table 2*). These three groups use Building Information Modelling (BIM) most widely for project design, coordination, and cost management. Engineering and architecture are significantly involved in digital model generation, collision detection, and spatial coordination, providing essential insights into BIM's operational impact on design processes and decision-making. Quantity Surveyors discuss cost planning, estimating, and 5D BIM applications, which are crucial to understanding BIM's impact on client project budgeting. BIM Coordinators and Managers, who specialise in BIM implementation techniques, data management, and technological integration, made up 9.0% of respondents. Project Managers (7.2%) represent the client's interests in project delivery, coordination, and value realisation, adding depth. Although underrepresented, GIS analysts, cost controllers, and project assessors offer additional perspectives on BIM's interplay with geographic data, financial controls, and compliance reviews. Overall, the combination of respondents provides a well-rounded, multidisciplinary view on how BIM tools are perceived and used to deliver client-focused outcomes across project stages.

***Table 2**. Respondent's profession.*

Category	Frequency	Percent	Valid Percent	Cumulative Percent
Architect	49	29.3	29.3	29.3
BIM Coordinator/Manager	15	9.0	9.0	38.3
Cost Controller	1	.6	.6	38.9
Engineer	54	32.3	32.3	71.3
GIS analyst	1	.6	.6	71.9
Project assessor	1	.6	.6	72.5
Project Manager	12	7.2	7.2	79.6
Quantity Surveyor	34	20.4	20.4	100.0
Total	167	100.0	100.0	

Respondents experience

The results in *Table 3* are reinforced by the varied experience in the construction industry of the respondents participating in the study. The majority of participants (40.1%) have 5-10 years of experience. This group might have been influenced by industry changes, including the adoption of BIM. A further 31.1% of respondents have 11-15 years of experience and have been exposed to pre- and post-BIM integration in project processes, enabling them to provide clients with information on the long-term effects of BIM on project delivery. 18.6% have less than 5 years of experience, which could have exposed them to BIM early in their careers and has given them a more up-to-date perspective on digital collaboration. The findings indicate that 10.2 per cent of respondents have over 15 years of industry experience and can compare BIM with traditional project delivery methods. Balanced representation of junior, mid-career, and senior staff will enable a holistic exploration of the practical implications of BIM for the construction projects clients face.

***Table 3**. Respondent's experience.*

Category	Frequency	Percent	Valid Percent	Cumulative Percent
11 to 15 years	52	31.1	31.1	31.1
5 to 10 years	67	40.1	40.1	71.3
Less than 5 years	31	18.6	18.6	89.8
More than 15 years	17	10.2	10.2	100.0
Total	167	100.0	100.0	

Impact of BIM on the clients project

This section, *Table 4*, presents the respondents' opinions on the impact of Building Information Modelling (BIM) on project outcomes, as perceived by the client. One hundred and sixty-seven valid responses were received, and the findings were analysed by applying descriptive statistics in determining the mean and standard deviation of each statement as applied to BIM and its contributions. The statistics show that respondents mostly agree that BIM offers significant benefits to clients across various project delivery methods. The answer, "With BIM, Bills of Quantities (BQ) creation by consultant Quantity Surveyor (QS) is less likely to be erroneous, and the cost generated is more exact, had the greatest mean score (M=4.05). This implies that BIM is considered a critical tool for enhancing cost accuracy and minimising human error in BQ preparation, which is important in construction projects to control costs and maintain financial stability.

eISSN: 2716-6481
https://doi.org/10.55197/qjssh.v7i1.1089

***Table 4**. Impact of BIM on the client's project.*

Category	N	Minimum	Maximum	Mean
BIM has led to improved stakeholder engagement and decision-making	167	1	5	4.02
Clients have expressed greater satisfaction due to faster project delivery enabled by BIM	167	1	5	3.86
BIM has improved communication between different teams involved in the project	167	1	5	4.02
The use of BIM has directly reduced the need for costly design changes or modifications	167	1	5	3.86
BIM has led to more sustainable and energy-efficient design outcomes	167	1	5	3.99
BIM has helped in improving project cost transparency for clients	167	1	5	3.86
By using BIM, Bills of Quantities (BQ) production by a consultant Quantity Surveyor (QS) results in fewer mistakes and more accurate costing.	167	1	5	4.05
Valid N (listwise)	167			

Moreover, two statements had the same mean scores (M=4.02): BIM has resulted in better stakeholder engagement and decision-making, and BIM has resulted in better communication among the various teams that worked on the project. The results show that BIM has a significant impact on stakeholder collaboration and coordination, which are necessary for making informed decisions and for effective project implementation. XIt was noted that the use of BIM enabled the attainment of sustainability goals. The argument that BIM has led to more sustainable, energy-efficient design solutions had a mean of 3.99, indicating a positive perception of BIM's role in promoting environmentally friendly design. The scores of three statements were the same, and the mean is 3.86: clients have experienced increased satisfaction as a result of quicker delivery of a project by the BIM, the need to make costly alterations to the design or adjustments has decreased, and the BIM has helped to enhance the project cost transparency to clients. Although these scores are slightly lower than others, they are still favourable, indicating that BIM has a positive effect on client satisfaction, cost management, and project transparency. The results show that BIM application is seen as having significant value for clients, especially in cost accuracy, collaboration, communication, sustainability, and delivery performance. All these revelations show that BIM goes a long way toward improving project efficiency and client satisfaction in contemporary construction practices.

Conclusion

The study's findings indicate that the application of BIM has had a positive impact on project outcomes, as perceived by clients. There was universal agreement amongst the respondents that BIM enhances stakeholder involvement and decision-making. Moreover, BIM has improved communication among project participants, minimised the cost of design alterations, and increased transparency into costs. Among the notable results is the increased accuracy of Bills of Quantities (BQs), which directly benefits clients by improving cost planning and estimation. The BIM integration throughout the project lifecycle, from initial design to management of client facilities, is a strategic tool that supports quality, efficiency, and customer satisfaction. These results prove that BIM is not merely a technological tool but also an important facilitator of the collaborative, value-based project delivery in the development of the project by its client.

Acknowledgement

This research study is self-funded.

Conflict of interest

The authors confirm that there is no conflict of interest among any parties involved in this research study.

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eISSN: 2716-6481
https://doi.org/10.55197/qjssh.v7i1.1089