



BUILDING INFORMATION MODELLING (BIM) CONTRACT ADMINISTRATION: CURRENT KNOWLEDGE, PRACTICES, AND ROLE ENHANCEMENTS FOR MALAYSIAN QUANTITY SURVEYORS

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Abstract

Building Information Modelling (BIM) has significantly improved planning, design, and construction productivity, while also strengthening the roles and functionality of Quantity Surveyors (QSs) in contract administration. This study aimed to assess the extent of QS knowledge and practices regarding BIM-based contract administration, thereby suggesting prospects for enhancing QS roles in the modernised era of the construction industry. A quantitative research method, involving questionnaire surveys, was employed. The results and findings from the descriptive statistics and reliability analysis revealed that although QSs have a relatively high level of knowledge regarding BIM contract administration, there is a lack of standardisation and documented references for managing BIM contracts in local practices. The study further proposed the “three-level enhancement framework” based on the ranked-survey responses to further improve the existing QS roles in contract management, specifically during the pre-construction, construction, and post-construction stages. This, in turn, contributes to a better understanding of the importance of QS involvement during the planning stage of BIM integration. Overall, the study outcomes promote full collaboration through a conducive digital environment that values the QS functional roles in digital construction and serves as a strategic enabler for urban planning and sustainable developments in Malaysia.

Keywords: Building Information Modeling (BIM) contract administration, quantity surveying roles, governance and procurement, construction development projects, Malaysia context.

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INTRODUCTION

Globally, the construction industry is a significant contributor, generating substantial revenue with an annual production of nearly \$10 trillion in construction-related goods and services (Chen et al., 2022). Thus, Building Information Modelling (BIM) has been established as a catalyst to support sustainable development, incorporating digital construction (CIDB, 2021). BIM plays a significant role in planning, designing, constructing, operating, and maintaining buildings throughout their entire life cycle (Alwee et al., 2023). As one of the leading parties in supporting sustainable development and digital construction, Quantity Surveyors (QSs) are well recognised for providing cost and contract management services from the initial stage until delivery completion.

Nevertheless, the published report by the Construction Industry Development Board (CIDB) demonstrates that the adoption rate of BIM accounted for 55% of its current uptake in the local construction industry (CIDB, 2021). Compared to the global players such as the United States (US), the current adoption rate achieved 80%, China at 52%, and India, which ranged at 10% to 18% (Zhen et al., 2025). These figures demonstrated that the current adoption in Malaysia remains lagging. These results further indicated that more opportunities can be learned from advanced global adopters to bridge Malaysia's policy needs and technological gaps. In countries such as the US and the United Kingdom (UK), strong government mandates have proven effective in accelerating BIM adoption (Chowdhury et al., 2024), creating industry-wide momentum. By contrast, in Malaysia, the high investment cost of BIM applications remains a notable concern, which continues to hinder broader uptake (Al-Ashmori et al., 2022).

In the current local context, many QSs still rely on conventional contract administration when managing cost and construction contract practices. This approach is hindered by a lack of technical interoperability when working with other parties, making it challenging to eliminate conventional working processes (Ahmed et al., 2022). Consequently, some QSs had difficulty understanding BIM practices and contractual approaches when managing actual construction projects (Shahid et al., 2025). Empirical studies further indicate that contractual impediments can lead to disputes, particularly during the implementation of BIM-based projects (Erpay & Sertyesilisik, 2021). Although BIM scholars acknowledge these emerging issues in recent literature, current empirical research exploring how the evolving roles of QSs, particularly in contract administration, is relatively unknown. Lack of standardised BIM guidance for current QS practices can hinder the effective contract and cost monitoring, in which both aspects are crucial for successfully delivering the project development.

In response to these issues, this study examines the extent of knowledge and practices among QS practitioners regarding BIM-based contract administration, which is critical for optimising BIM implementation in sustainable development construction projects. To achieve this aim, three research objectives are defined: (1) to identify the current knowledge on BIM contract administration amongst QS in Malaysia; (2) to investigate the current practices on BIM contract administration amongst QS; and (3) to propose enhancements to the QS roles on BIM contract administration to support the revolution of digital construction for future Malaysian construction industry.

Furthermore, a specific focus on the Malaysian context is necessary to align with recent efforts by the government and the CIDB. This is outlined in the National Construction Policy 2030 (NCP) and the new economic framework, *Ekonomi Madani*, which emphasises the need for future enhancements in BIM implementation and other technological tools in the built environment. Additionally, improvements in the contractual and governance aspects of BIM implementation in Malaysia are essential to enhance the practical usability of technology integrations in projects, particularly for Qs who also serve as contract administrators when managing construction contracts. Moreover, QS's expertise in governing the procurement policies and risk management facilitates the integration of digital technologies into planning and development, thereby empowering more resilient and sustainable developments for the future Malaysian construction industry.

LITERATURE REVIEW

Current Knowledge of BIM Contract Administration Among Quantity Surveyors

For the past two decades, BIM has emerged in the construction-related literature as a tool that can develop robust modelling systems integrating people, processes, and technology for various design, construction, and operation activities (Omar & Mohd Fateh, 2023). Gerbert et al. (2016) claimed that digital technologies such as BIM employed in urban development projects will significantly reduce project lifecycle costs by approximately 20% and improve project delivery timelines (Gerbert et al., 2016).

During the planning stage, BIM enables local authorities to review planning submissions using an automated compliance checking process, thus minimising human errors and increasing the effectiveness of the approval workflow (Fuji et al., 2024). During the design stage, BIM is recognised as a platform that facilitates data and model exchange among stakeholders, thereby eliminating work duplication (Zainon et al., 2018). It has also been revealed to help reduce construction costs and increase work productivity, particularly during the construction phase. Thus, there is no doubt that the foundation of

digitalisation in the construction industry is the information and mathematical modelling of end-to-end processes. This enables work to be optimised in terms of cost, time, business suitability, and with a minimum negative impact on the built environment (Honcharenko et al., 2021). As the cost estimator involved in estimating costs for the whole project lifecycle, QSs must understand that regulatory compliance through BIM-based planning processes can streamline data management and project monitoring during construction and operation. This is particularly true for large-scale projects that involve the strategic integration of township developments and multiple utilities and infrastructure considerations.

In construction development projects, QSs extend beyond managing costs and budgets. Their roles have also expanded to include governance, procurement and contract management tasks. Past scholars have criticised the scope of work associated with QSs as being time-consuming and prone to human errors (Alwee et al., 2023). An empirical study noted that applying BIM technology has resulted in more comprehensive and accurate drawings while reducing the workload of QSs and minimising assumptions and misinterpretations in measurement tasks (Ismail et al., 2021). By adhering to the proper BIM process and workflow, project stakeholders, including QSs, can enhance their knowledge of cost and contract administration tasks through seamless collaboration and reduce communication gaps with other project stakeholders.

QSs may find that assessing and analysing cost management procedures becomes much easier through BIM applications than with conventional techniques, provided they possess the right process and workflow knowledge (Keung et al., 2022; Soon et al., 2024). In line with this, the idea that the application of BIM in the construction industry is becoming increasingly recognised and utilised. For example, in Hong Kong, BIM has become commonly integrated for public and private projects (Keung et al., 2022). Although the rate of BIM usage is increasing, the involvement of QSs in BIM remains limited. This validates the argument that there is still limited knowledge on implementing BIM into reality, particularly when conducting cost estimation and other contract administration tasks by QSs (Alwee et al., 2023).

Current Practice on BIM Contract Administration Among Quantity Surveyors

To achieve the project's goals and objectives, QSs can leverage the full potential of BIM to enhance their professional practices and improve the efficiency of cost and contract management. During the pre-design estimation phase, a QS will be required to produce a feasibility study to determine the building cost, utilising limited sketches and assumptions about the building (Alwee et al., 2023). This cost plan is crucial in determining the time and budget allocations for the

construction project. Considering this evidence, allocations of building cost data can be easily and automatically extracted from the model. Thus, BIM helps generate a reasonable and accurate cost estimation required by Qs, while also identifying potential risks of cost overruns (Halil et al., 2024). An e-tender can be a web-based platform (Azizi et al., 2021). Accordingly, BIM simplifies the tender process, reducing the time and workforce required to produce cost estimates while increasing the accuracy and reliability of the results (Rashidi et al., 2024). The contractor will only need to download the documents from the website and then submit the Bills of Quantities (BQ) with the pricing to the website for the following tender evaluation process. In the pre-construction stage, the production of QS can be conducted seamlessly using an automation process with BIM-plugged-in software. Updating BQ could be performed much more easily when there are changes in the model (Soon et al., 2024).

Once the contract was awarded between the client and contractor, important contract administration tasks involved site supervision and monitoring to assess project progress for interim payment certifications (Alwee et al., 2023). This construction stage also requires the QS to spend more time visiting the site every month to check the actual work progress against the planned schedule. Results from empirical data support that BIM can facilitate production and visualising work progress, as monitored using Unmanned Aircraft System (UAS) for tracking, monitoring, and site verification at construction projects (Chen et al., 2022). This can effectively increase the accuracy of data collection on-site progress and speed up the quantity of surveying work. Once the construction is completed, BIM information and data significantly aid maintenance purposes (Ismail et al., 2021) when developing maintenance plans and schedules. Taking these considerations together, BIM can also be utilised effectively to enable informed decision-making based on project performance, operational aspects, and economic factors.

Enhancements to the Quantity Surveyors' Roles in BIM Contract Administration

During the Pre-construction Phase

Improving the contract administration process is crucial to ensure transparency through early integration, such as in the BIM-based planning and designing stages. Detailed policy guidelines and BIM contract requirements should also be outlined in accordance with project standards and outcomes (Alwee et al., 2023). Clearly defined project standards and procedures can help parties utilise BIM effectively during the pre-construction stage to accurately estimate the project's financial costs and expenses, facilitating bidding during the tendering process (Rashidi et al., 2024). Additionally, Manzanares et al. (2023) proposed a more streamlined estimation process that provides real-time and up-to-date data lock-

in, preventing missing items from occurring during the estimation process. Accordingly, clarifying rights and obligations among all contracting parties should be established and identified during the design phase to ensure a smooth workflow and prevent future conflicts between the design team and the construction company (Mohammadi et al., 2024).

During the Construction Phase

One of the advantages of 4D models is their ability to visualise the progress of construction activities, allowing for the monitoring and control of construction time (Alwee et al., 2023). Therefore, BIM can provide a clear understanding of comparing the planned schedule with the actual progress on site to ensure that the project aligns with the project timeline. Moreover, it could identify early risks to avoid delays, and corrective actions can be planned as soon as possible. Apparently, the role of BIM in managing conflicts and reducing disputes has been proven to help manage and resolve conflicts in the construction industry. This is further confirmed by Khawaja and Mustapha (2021), who remarked that BIM has been demonstrated to be highly effective in reducing the number of variations and Requests for Information (RFIs), which helps to achieve certainty goals in terms of time and cost.

During the Post-construction Phase

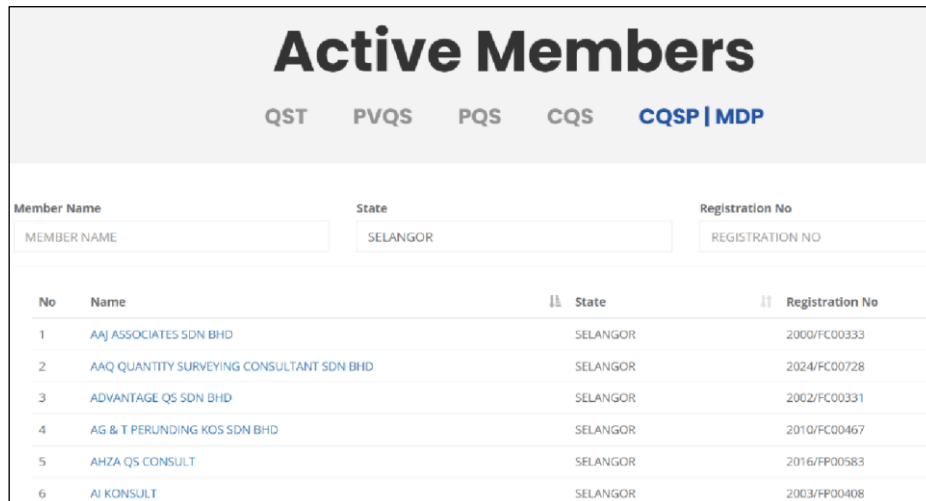
The significant benefit of BIM in this phase is the transfer of building data to a Facility Management (FM) system, which includes integration, allowing for more efficient and effective scheduling, building assessment, and maintenance history tracking (Zainon et al., 2018). Additionally, BIM can generate data directly from the cloud database for maintenance planning purposes, enabling it to create an optimal maintenance schedule tailored to the project's specific conditions. This process is crucial for Qs to understand, as multiple parties must comprehend how BIM operates as the centralised data system for the decision-making process (Alwee et al., 2023; Ismail et al., 2021).

To advance specific knowledge and elevate current practice among QS involved in BIM-based projects, it is evident that BIM facilitates information flow and project coordination from the pre-construction process through to the post-stage for future operational works. In the pre-construction phase, the results of the feasibility study and the tender process can be simplified in the estimation process. During construction, BIM is viewed as helpful in monitoring and controlling construction progress to avoid risks and disputes. Meanwhile, during the post-construction phase, BIM effectively plans maintenance scheduling for later operation and maintenance.

Conceptually, the synthesis from the literature review maps out three measurable constructs known as (i) Knowledge, (ii) Practice and (iii) Role enhancements that become the dimensions used in the data collection process.

RESEARCH METHODOLOGY

This study employs a quantitative research approach to assess the identified constructs and variables from the literature on the QSs' knowledge, current practices and future enhancements in BIM contract administration. The methodology is designed to systematically collect, analyse, and interpret data to provide empirical insights from the two components and propose potential improvements to the QS roles for future governance in managing BIM construction contracts.



The screenshot displays the 'Active Members' section of the BQSM website. It features a header with navigation tabs for QST, PVQS, PQS, CQS, and CQSP | MDP. Below the header, there are search filters for Member Name, State (currently set to SELANGOR), and Registration No. A table lists six members with their respective details.

No	Name	State	Registration No
1	AAJ ASSOCIATES SDN BHD	SELANGOR	2000/FC00333
2	AAQ QUANTITY SURVEYING CONSULTANT SDN BHD	SELANGOR	2024/FC00728
3	ADVANTAGE QS SDN BHD	SELANGOR	2002/FC00331
4	AG & T PERUNDING KOS SDN BHD	SELANGOR	2010/FC00467
5	AHZA QS CONSULT	SELANGOR	2016/FP00583
6	AI KONSULT	SELANGOR	2003/FP00408

Figure 1: List of registered members of QSs with the BQSM
(Source: www.bqsm.gov.my)

In particular, the primary data was collected using structured questionnaires distributed to QSs in *Klang* Valley, Malaysia. The finalisation of the population is being collected through registration with the Board of Quantity Surveyors Malaysia (BQSM), which has produced a total of 2,505 members. After formulating the sample size calculation, the required number of respondents was reduced to 246. This sample size included QSs in various professions, such as QS technologists, provisional QSs, professional QSs, consultant QSs, and consulting quantity surveying practitioners (refer to Figure 1). The final data collection stage yielded 37 responses (R: 37, equivalent to a 15% response rate) following a series of online survey distributions and then proceeded to the data

analysis stage. Note that low participation from the respondents presented a limitation in gathering replies and feedback, despite several reminders, follow-ups, and targeted emails being conducted to overcome this challenge in the data collection process.

Previous scholars have criticised the acceptance of modest participation (Dillman et al., 2014), which is unusual, particularly in industry-based and specialised respondent group surveys. This includes those in the construction-related field, where practitioners often have heavy workloads that lead to survey fatigue during the data collection process. Previous research (Fellows & Liu, 2015) also acknowledged that this issue is commonly faced by scholars in construction management research, whereby respondents are often inaccessible due to time constraints. Thus, a step was taken to reduce the risk of non-response bias. For instance, the study included cross-checking of the respondents' demographics against the broader target population (by referring to the BQSM website), which resulted in no substantial bias in the research sample size. Indicatively, the findings somehow remained reliable and informative as they were obtained from experienced QS practitioners across diverse categories (developers, contractors, consulting firms, and others).

The questionnaire included multiple-choice questions, Likert scale responses (scale 1-4 to minimise neutral bias), and open-ended questions to capture a diverse range of perspectives. The collected data were analysed using the Statistical Package for the Social Sciences (SPSS) to ensure rigorous statistical interpretation. The analysis consisted of (1) descriptive analysis that is used to summarise the characteristics of the respondents, (2) frequency distribution that is applied to determine common responses, and (3) reliability test that is conducted to measure the internal consistency of survey responses, ensuring the validity of the results. A Cronbach's Alpha test was performed to assess the internal consistency of the questionnaire responses. The reliability coefficient aimed for a threshold of 0.7 or higher, ensuring data consistency.

Table 1: Results from the reliability test

Construct	Number of items	Cronbach's Alpha	Level
QS current knowledge	10	0.809	Good
QS current practices	10	0.887	Good
QS roles for future enhancements	15	0.947	Excellent

Based on Table 1 results from the reliability tests demonstrated that coefficient values for all three components are accurate, consistent and reliable for the subsequent interpretation of results and findings (Cronbach's Alpha coefficient of 0.809 for Objective 1 on the QS current knowledge coefficient of

0.887 for Objective 2 on the QS current practice, and the Cronbach's Alpha coefficient of 0.947 for Objective 3 on the QS roles for future enhancements).

RESULTS AND FINDINGS

Background of the Respondents

Demographic information refers to the background details of the target respondents. By referring to Table 2, the study revealed that the largest number of respondents had less than five years of experience in construction, accounting for 18 (48.6%) of the total.

This was followed by 11 to 15 years of experience, which accounted for seven (18.9%) of the total. Finally, the lowest experience in construction was six to ten years of experience and more than 15 years, which resulted in a total of only six for each (16.2%). Regarding the current professions of the respondents, the largest number of current professions are from consulting firms, which comprise a total of 13 (35.1%). This is followed by 11 QSs from contractors (29.7%) and seven from other fields (18.9%). The professions collected here include those from government agencies and claims consulting agencies. Lastly, the lowest profession among the respondents is that of developers, at six (16.2%).

Table 2: Information about the respondents

Item	Information	Number of Respondents	Percentage (%)
Experience in Construction Sector	Less than 5 years	18	48.6%
	6 – 10 years	6	16.2%
	11 – 15 years	7	18.9%
	More than 15 years	6	16.2%
Quantity Surveying Field	Developer	6	16.2%
	Contractor	11	29.7%
	Consulting Firm	13	35.1%
	Others	7	18.9%
Experience with BIM Implementation	Less than 3 years	30	81.1%
	4 - 6 years	5	13.5%
	7 -9 years	1	2.7%
	More than 10 years	1	2.7%

The above table also presents the respondents' years of experience in BIM implementation. The study results reveal that the largest number of years of experience in BIM implementation is less than three years, which accounts for 30 (81.1%) of the total. Then, it is followed by four to six years of experience, which accounts for five years (13.5%). Finally, the lowest experience in BIM implementation is seven to nine years and more than nine years, resulting in one each (2.7%). Therefore, respondents' involvement in BIM implementation is still relatively new. Nonetheless, the results suggest that strong theoretical

understandings, embedded in formal education, help them in their early-career development, although they have limited hands-on practice in the construction industry.

Current Knowledge of BIM Contract Administration Amongst QS

A few significant results are presented in Table 3 regarding the current understanding of BIM contract administration among QSs in the local construction industry.

The requirement for a strong financial investment (K5) was ranked highest (mean score = 3.76) in implementing BIM and is also acknowledged as one of the challenges faced in the current industry. QSs are required to conduct additional cross-checking work (K6), ranked second, with a mean score of 3.65. The third-ranked group, with a mean of 3.51 regarding the current knowledge, indicated that updating design changes can be performed seamlessly (K2), as agreed upon by the respondents involved in the study. Fourth place (mean = 3.46) highlighted that BIM could assist decision-making, indicating that most QS agreed with that functionality when administering construction projects using BIM-based processes (K4). Additionally, ranked number five with a mean of 3.38, the study revealed that BIM helps prevent data loss and errors (K3) as part of the current knowledge widely agreed upon by QS when integrating with BIM.

Table 3: Current knowledge of BIM contract administration amongst QS

Item	Current Knowledge	Mean	Standard Deviation	Rank
K1	BIM technology provides comprehensive and accurate information, thus reducing QS workloads	3.35	0.58766	6
K2	The process of updating design changes can be done seamlessly with the help of BIM	3.51	0.60652	3
K3	BIM helps prevent data loss and errors	3.38	0.72078	5
K4	BIM assists the decision-making process throughout the project	3.46	0.60528	4
K5	Strong financial investment is required to successfully implement the BIM in practice	3.76	0.43496	1
K6	QSs are required to do additional cross-checking of data in the BIM cloud to ensure the accuracy of data	3.65	0.53832	2
K7	BIM models need to be updated regularly to deal with real-data changes from time to time	3.30	0.70178	7

With a mean score of 3.35, QS further suggested that comprehensive and accurate information could reduce the workload during collaboration with other project stakeholders (K1). Finally, with a mean of 3.30, many QS understood that regular updates on the BIM models are necessary to capture real-

world changes over time during project implementation (K7). Although respondents reported being relatively proficient in BIM-based knowledge, it may be inferred that major barriers such as high investment costs and added workload could contribute to their constraints in implementing BIM effectively.

Current Practices on BIM Contract Administration Amongst QS

As presented in Table 4, the analysis results revealed several key findings regarding the current practice of BIM contract administration among Qs in the local construction industry. With a mean score of 3.59, the highest, most respondents agreed that operations and maintenance for buildings after completion (P8) could be achieved using 5D models that support lifecycle costings for facilities management. The process of generating BQ can be automated when integrating the work process via BIM integration (P3), which is ranked second, thereby increasing productivity in completing work (mean score = 3.54). The third mean score, 3.54, indicated that BIM contract administration practices could be streamlined for e-tendering and digital documentation (P4), thereby simplifying the lengthy conventional tendering process, which can be time-consuming.

Table 4: Current practice of BIM contract administration amongst QS

Item	Current Practice	Mean	Standard Deviation	Rank
P1	Preparation of a feasibility study during the planning stage is more efficient compared to the conventional process	3.41	0.79790	6
P2	The extraction process of cost data can be done directly from the BIM models to produce an accurate cost analysis	3.41	0.68554	7
P3	The process of generating BQ could be done automatically, which can increase productivity	3.54	0.55750	2
P4	e-tendering and digital documentation can simplify the complicated and long process of the traditional tendering process	3.54	0.69100	3
P5	The tender evaluation process can be done easily with the help of BIM	3.19	0.90792	8
P6	The tracking of project progress, interim payments, and variation works can be done effectively	3.43	0.80071	5
P7	Analysing construction progress can be done remotely with the help of visualisation and progress monitoring using 4D models and simulations	3.51	0.50671	4
P8	Operations and maintenance can be achieved with the use of 5D models	3.59	0.55073	1

The fourth-ranked group noted that most QS respondents believed progress at the site could be monitored remotely with the aid of visualisation (P7), especially when using 4D models to track site progress through model simulations (mean score = 3.51). The respondents further agreed that tracking work progress, particularly for tracking variation works and monitoring interim payments (P6), could be performed effectively using a BIM-based process. This fifth rank achieved a mean score of 3.43 from the analysis. Additionally, with a mean score of 3.41, the study revealed that work associated with preparing feasibility studies could streamline various QS tasks from the outset (P1), thereby increasing efficiency in meeting the client's needs. Therefore, BIM enhances the data extraction process to generate accurate cost data, facilitating effective cost analysis (P2). The final mean score from the analysis (3.19) revealed that many QS agreed that having the right knowledge about the BIM work process helped them conduct the tender evaluation process more easily (P5) compared to existing manual processes still used in the industry.

The data appears to suggest that BIM practices enhanced automation processes in preparing BQ, facilitated seamless tendering procedures, and improved site tracking and monitoring works. However, this should rely on their sufficient BIM experience to work effectively via digitalised working processes.

Enhancement to the QS Roles in BIM Contract Administration

The respondents were asked to propose enhancements to the QS roles in managing BIM contract administration for future projects (Table 5). For contract administration during the pre-construction stage, clear stipulations on roles and responsibilities, with a mean of 3.43, demonstrated the highest agreement, emphasising the need for all project stakeholders to understand their obligations regarding BIM implementation in various project implementations (R2). The second-highest mean (3.32) indicated that clear stipulations regarding contract requirements are essential, as they identify each party's roles, including BIM work specifications, to ensure that contractual responsibilities are clearly defined (R3). Thus, transparency in the BIM contract formation is also essential (mean score = 3.30) to ensure that the client determines their BIM needs and deliverables (R1), ensuring all parties involved in BIM design and construction comply with the BIM requirements.

For contract administration during the construction stage, the highest mean score from the analysis (mean score = 3.46) indicates that a proper risk mitigation process must be determined early before any conflicts and issues arise during construction (R5). This ensures that the minimisation of actual risk occurrence can be considered early during project implementation. The second rank, with a mean score of 3.35, concerns all parties in optimising construction scheduling for site monitoring using a real-time platform to enhance collaboration

and provide greater transparency in achieving work completion (R4). Many respondents also suggested that communication at various levels in BIM collaboration (mean score = 3.30) needs to be improved, thus preventing contractual disputes from occurring while managing the projects (R6).

Table 5: Enhancement to the QS roles in BIM contract administration

Item	Enhancement to the QS Roles	Mean	Standard Deviation	Rank
During Pre-construction				
R1	Transparency and efficiency in the BIM contract formation	3.30	0.66101	3
R2	Clarification on the roles and responsibilities of all project stakeholders	3.43	0.55480	1
R3	A clear understanding of contract requirements by defining the roles, specifications, and BIM deliverables	3.32	0.62601	2
During Construction				
R4	Optimisation of construction schedules via visualisation and monitoring through real-time progress	3.35	0.58766	2
R5	Conflicts and issues during construction must be resolved by mitigating the risks early	3.46	0.60528	1
R6	Communication and collaboration should be improved to reduce and prevent disputes during construction	3.30	0.70178	3
During Post-Construction				
R7	The decision-making process for planning maintenance activities should be done by centralising all data in the asset model	3.35	0.67562	1
R8	Streamline the data transfer process for the maintenance and operation phase to minimise the risks of errors	3.16	0.86646	2
R9	Improving the resource allocations for maintenance and operations management	3.35	0.63317	1

For the contract administration during the post-construction stage, most respondents highlight the significance of improving the decision-making process or planning maintenance activities using a centralised data management system to conduct asset management (R7) after the project is handed over to the end-users. Most respondents further agreed that having clear resource allocations is necessary to manage people, processes, and technology (R9) for operation and maintenance post-construction (mean score = 3.35). Finally, with a mean score of 3.16, there is an urgency to ensure that the data transfer process for maintenance and operation is conducted accurately to minimise any risks of errors (R8). This is especially relevant when relying on technology to monitor the

operational parts of maintaining building performance. Discussions on the overall results and findings will be elaborated on next.

DISCUSSIONS

Based on the data collected through questionnaire surveys and the findings discussed, a three-level enhancement framework of the study is proposed. As presented in Figure 3, the framework outlines three dimensions: “Knowledge,” “Practice,” and “Enhancement of Roles,” which QSs must consider in supporting their roles as enablers that function in various project phases, including planning, design, construction, operation, and maintenance. The first dimension indicated that financial investment (K5), cross-checking for data accuracy (K6), and ease of updating BIM data and information (K2) are the three highest priorities in current knowledge. These conceptualise the cost feasibility, data reliability, and operational efficiency in BIM contract administration. Meanwhile, the second dimension demonstrated that 5D models for operations and maintenance (P8), automatic BQ generation (P3), and e-tendering using digital documentation (P4) are the most crucial practices being implemented among QS managing BIM-based projects. The findings suggest that process simplification via integrated processes can help streamline the QS workflow by utilising BIM models in a digital environment. Thus, the final dimension in Figure 5 demonstrated that clarifications about roles and responsibilities during the pre-construction (R2), risk mitigations on conflicts during construction (R5) and centralising all data using an asset model during post-construction (R7) are the most significant improvements that a QS, as a professional enabler, must elevate to improve governance mechanisms from existing conventional roles of BIM collaboration. Collectively, these findings indicated that additional training for QS that includes technical procedures and implementation guidelines is necessary.

Although the feedback from the study is relatively limited due to a small sample size, other practical implications can be observed in terms of finances, which may become a major barrier to BIM’s implementation. This validates the argument that a significant investment is required for firms to adopt BIM technology, as it necessitates periodically upgraded hardware to ensure the software can run smoothly and efficiently deliver the work without difficulty (Ismail et al., 2021). Nevertheless, QS practitioners agree that BIM can streamline the lengthy and complicated process of updating design changes. This is attributed to the fact that quantities issued from the model are automatically synchronised and updated through the model (Zainon et al., 2018), which can indirectly help ensure the accuracy and consistency of data in real-time, reduce the risk of data transfer errors, and save time.

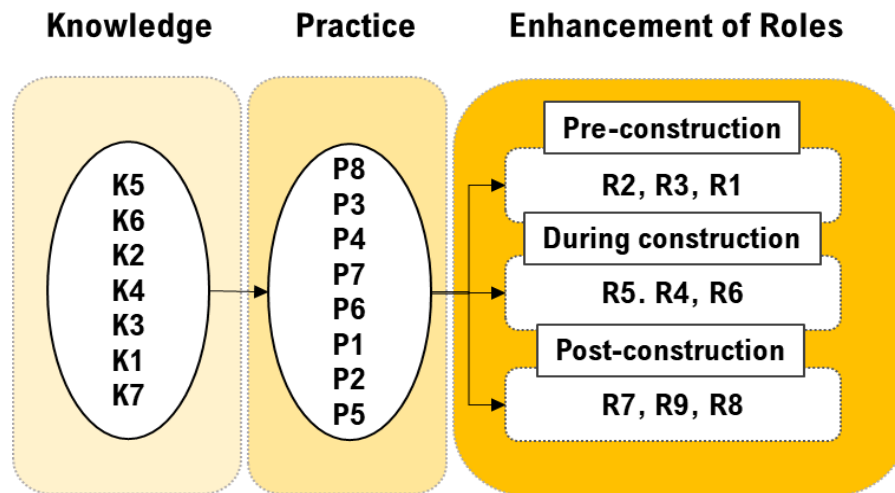


Figure 3: Three-level enhancement framework of the QS knowledge and practices and the roles for BIM contract administration

Considering the implications, it stands to reason that most QSs recognise the efficiency of BIM in maintenance operations, due to its data management and control capabilities, as well as its ability to provide better interpretation by linking real-time data in models. BIM can be integrated into various building systems to enable real-time monitoring of building performance, including lifecycle costs and energy consumption. Evidence strongly suggests that the use of paper in the e-tender system has been significantly reduced by up to 90%, resulting in a decrease in administrative and transaction costs associated with producing tender documents (Azizi et al., 2021). Therefore, implementing BIM into practice has provided a solution to time-consuming issues, such as introducing e-tenders, which are more time-saving (Halil et al., 2024).

From a policy perspective, a notable observation demonstrated that the roles and responsibilities of all stakeholders must be clearly defined and specified in the contract during the early stages of the BIM integration process. These roles should be clearly outlined during the pre-construction phase for the entire BIM contractual integration life cycle (Alwee et al., 2021). Note that the lack of clarity and adequacy in BIM contract guidelines will lead to more contract and regulatory issues (Alaitobi et al., 2024), especially during the construction collaboration process. Therefore, the study somehow revealed that BIM collaboration can minimise the occurrence of disputes, mitigate their impact, and manage them proactively (Khawaja & Mustapha, 2021). BIM can identify and resolve clashes at the early stages, preventing costly rework and delays, which are a major source of disputes.

CONCLUSION

This study has comprehensively examined the participation and roles of Qs, particularly in BIM contract administration, focusing on current knowledge, existing practices, and potential areas for improvement despite the limited number of respondents who were involved in the study. The findings highlight that while QS professionals generally understand the significance of BIM, several gaps hinder its full integration into the contract administration process. The research findings indicate that Malaysian QS professionals have a fundamental understanding of BIM contract administration. However, a lack of standardised guidelines and legal frameworks tailored to BIM practices leads to implementation inconsistencies, although BIM is already utilised in QS practices, primarily for cost estimation, clash detection, and project tracking. To optimise BIM implementation in contract administration, this study proposes a three-level enhancement framework that can serve as a guide, such as for the BQSM, to align the needs for improving the QS competencies, thus bridging the current gaps through knowledge, practice, and role-based enhancements for the modernised Malaysian construction industry.

This study offers both theoretical and practical implications for the field of BIM contract administration, which is also vital in supporting the sustainable development goals of the construction industry. At the same time, the findings offer valuable insights for policymakers and industry stakeholders to develop standardised contractual guidelines, training modules, and regulatory frameworks that facilitate smoother BIM implementation.

While this study provides significant insights, it is not without limitations. The research was conducted primarily in the *Klang* Valley region, which may not capture the broader implementation of BIM in Malaysia. It is pertinent to note that this study relied on questionnaire surveys, which may not have fully captured the depth of the practical challenges faced by QS professionals and other practitioners, such as urban planners, architects, and other designers, who contribute to their roles in contract administration. Thus, qualitative methods, such as interviews and case studies, should also be considered to gain deeper insights into the challenges and best practices that involve multiple disciplines. Future studies can further bridge the gap between BIM theory and practice by addressing these areas, contributing to a more structured and efficient contract administration process in Malaysia's construction industry.

ACKNOWLEDGEMENT

The authors would like to express their sincere appreciation to the Faculty of Built Environment and Universiti Teknologi MARA (UiTM) for the support and assistance provided throughout the completion of this study.

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Received: 5th December 2025. Accepted: 6th February 2026