Journal of Engineering, Project, and Production Management
2025, 15(3), 0015

Factors Affecting Soft Cost in BIM-Based Construction Projects

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Project Management
Received December 20, 2024; revised January 6, 2025; accepted January 6, 2025
Available online June 30, 2025

Abstract: Building Information Modelling (BIM) is transforming the construction industry by improving project efficiency, accuracy, and teamwork. However, failure to determine accurately soft costs during BIM-based construction projects can lead to financial uncertainty and management issues, making it difficult to assess the return on investment (ROI) of BIM. Identifying the factors that influence BIM-related soft costs is crucial for determining the ROI of BIM. To address this issue, this study aimed to investigate the factors affecting soft costs in BIM-based construction projects, using Malaysia as a case study. Data collection involved conducting semi-structured interviews with BIM professionals, followed by thematic analysis to analyse the collected data. The findings revealed that the factors influencing soft costs can be categorised into two main themes: organisational factors and project factors. Within the former, the subthemes included development charges, certification fees, commissioning fees, and ongoing maintenance costs. Meanwhile, project factors encompassed contingency fees, levy fees, and documentation fees. Understanding these factors is crucial for determining the ROI of BIM, which can drive more widespread BIM implementation in developing countries. The study reveals that accurately identifying the factors influencing soft costs in BIM-based construction projects is essential for effective cost management. As a result, the findings emphasise that these factors must be addressed in order to improve financial planning and project execution in the construction industry. The originality of this study lies in its focus on soft costs within BIM-based construction projects, an underexplored area of the existing literature. This nuanced understanding will help organisations and policymakers to manage costs more effectively, contributing to more efficient construction practices and supporting the UN Sustainable Development Goals 9: Industry, Innovation, and Infrastructure and 11: Sustainable Cities and Communities by promoting sustainable building practices and resilient infrastructure development.

Keywords: Building Information Modelling (BIM), soft cost, return on investment (ROI), interviews, thematic analysis

DOI 10.32738/JEPPM-2025-0015

1. Introduction

Soft costs in the implementation of Building Information Modelling (BIM) present significant challenges for construction project stakeholders. Encompassing expenses not directly tied to physical construction, these costs include BIM software licensing, staff training, data management, integration challenges, and coordination efforts (Farouk et al., 2023). Soft costs constitute a substantial proportion of project budgets, potentially up to 40%, and their mismanagement can severely impact profitability. Soft costs can cause many issues in BIM-based construction projects, impacting different aspects of project execution (Fanning et al., 2015; Jang et al., 2022). Quality assurance challenges, such as rectifying errors in inaccurate BIM models during operational and maintenance phases, often create the additional expenses of rework and corrective actions, contributing to an escalation in soft costs (Zadeh et al., 2015). Cost overruns, stemming from project mismanagement or unforeseen issues in BIM implementation, result in unplanned spending on troubleshooting, retraining staff, or addressing compatibility issues, which disrupts project budgets and timelines (Omotayo et al., 2022). Workflow inefficiencies, like rushing through BIM workflows without proper checks, can introduce errors and inconsistencies, necessitating additional time and resources for rectification, leading to soft costs associated with delays and inefficient resource utilisation (Nawari and Ravindran, 2019). ROI (return on investment) is critical in assessing the economic viability of implementing BIM. It is a fundamental metric for measuring the profitability or loss incurred relative to the investment costs.

Determining the ROI of BIM can be complex and challenging due to the different factors and methodologies involved (Sompolgrunk et al., 2023). Even in ROI calculation, differing approaches have been used to calculate BIM ROI, with interpretations varying based on the method used. For instance, one method evaluates ROI based on gains and investment costs, although another method developed by Autodesk considers ROI in relation to exceeding 100% (Sompolgrunk et al., 2023). The intricacies of BIM ROI calculation stem from the multifaceted nature of implementing BIM, which encompasses expenses like software acquisition, technical support, hardware, training, services, and contingencies. These challenges are further compounded by issues such as information management system complexities (Kocakaya et al., 2019), control dynamics (Ye, 2021), surveillance concerns, and inefficiencies arising from the duplication of effort in projects involving non-BIM users (Pradeep et al., 2020). Despite the lack of a universally agreed-upon methodology for calculating BIM ROI, leveraging soft cost calculations can provide valuable insights into determining the ROI of BIM implementation (Lee and Lee, 2020; Sompolgrunk et al., 2023). Soft costs, which include indirect expenses related to project management, coordination, and efficiency, can significantly influence overall ROI assessments (Farouk and Rahman, 2023).

Understanding soft costs in BIM enables stakeholders to gain a more comprehensive understanding of the economic impact and benefits of BIM implementation, thus aiding in their making informed decisions regarding its implementation and investment (Jasiński, 2021). Identifying the factors affecting soft costs in BIM-based construction projects has several significant benefits. Firstly, it leads to better cost management (Siong, 2021; Yarmohammadi and Castro-lacouture, 2018), enabling stakeholders to allocate budgets more effectively and avoid unnecessary expenses (Syed Jamaludin et al., 2022). Secondly, it enhances the overall understanding of BIM, improving cost estimation accuracy and project planning. This increased accuracy encourages more widespread BIM implementation as stakeholders become more confident and less fearful of investing in BIM. Thirdly, it gives BIM managers more background about the factors affecting BIM-based construction projects. Furthermore, understanding these factors aids in the ROI for BIM, providing clear evidence of its long-term benefits and efficiency. Overall, this knowledge promotes more efficient project execution and more successful BIM-based construction projects. Hence, it is critical to study the factors affecting soft costs in BIM-based construction projects.

Given this background, the following research questions emerged: What factors affect soft costs in BIM-based construction projects? and How do these factors impact soft costs in BIM-based construction projects? To answer these questions, this study aimed to investigate the factors affecting soft costs in BIM-based construction projects, using Malaysia as a case study. To achieve this, semi-structured interviews with BIM professionals were conducted. The acquired data was analysed using thematic analysis. Finally, a list of factors related to soft costs in BIM-based construction projects was developed. This study contributes to an improved understanding of soft costs, focusing on BIM-based construction projects. This study contributes to a better understanding of soft cost and bridges the existing knowledge gap by providing specific factors affecting soft costs in BIM-based construction projects. The study findings could serve as a valuable resource for stakeholders in addressing the challenges of achieving adequate construction readiness in BIM-based building projects. Stakeholders could use the list provided in this study to manage project budgets and ensure profitability effectively. Moreover, soft costs can be a step towards determining the ROI of BIM, which would help non-BIM organisations realise the ROI of BIM. Incorporating soft costs into ROI calculations could help companies better assess the economic impact of BIM implementation and make informed decisions. Lastly, the inclusion of soft costs could mean that personal and organisational resistance to change is overcome by addressing the uncertainty about the ROI of BIM.

2. Literature review

2.1. Soft cost in construction projects

Limited research has been undertaken on soft costs in construction projects. Most of the existing research is related to green building. Nurul Zahirah and Abidin (2012) highlighted that these often hidden soft costs, including insurance, developer experience, design expenses, certification, commissioning, and energy modelling, contribute significantly to the green premium. For instance, higher insurance costs are linked to the increased risk involved in green building, while experienced developers can mitigate some of the cost through smarter design decisions. Although these soft costs play crucial roles in overall project expenses, their relative importance remains underexplored, indicating a need for further research. Azizi et al. (2015) identified eighteen soft cost elements (SCEs) in construction, which were categorised into Professionals, Legal Requirements, or Procedures. Specific to green buildings, additional SCEs like green building consultants, certifiers, and registration contribute to the extra costs of meeting certification requirements. The research suggested that these soft costs influence developers' decisions on green investments, with industry experts expressing concerns over the financial implications, highlighting the need for government intervention to incentivise green building. Research by Abidin and Azizi (2021) shows that soft costs, although often overlooked, significantly impact project planning and management. These costs, covering aspects such as professional fees and authority requirements, are critical in both conventional and green projects. Although green certification costs are typically under 2% of the total, they indirectly affect other soft costs like professional fees and design changes. This contributes to the green cost premium, potentially deterring developers unless incentives are offered. The study emphasises the need for stakeholder collaboration to streamline processes and reduce soft costs, thus promoting sustainable construction practices.

2.2. Costs in BIM projects

Extensive research has been conducted on BIM cost management (Farouk and Rahman, 2023). For example, Lu et al. (2014) presented a cost-benefit analysis (CBA) of adopting BIM in construction projects. Using a quantitative approach, surveys and case studies were employed to gather data from different stakeholders involved in BIM projects. The study examined the relationship between the time and effort invested in BIM processes and the resulting benefits, such as improved design quality, reduced rework, and enhanced collaboration. The study introduced time-effort distribution curves to visualise resource allocation during BIM implementation, providing stakeholders with a clearer framework with which to evaluate the financial viability of adopting BIM. Jrade and Lessard (2015) developed an Integrated Time-Cost Management System (ITCMS) and tested it in a real-case scenario. Consisting of modules for time and cost estimating, scheduling, visualisation, and Earned Value Management (EVM), the system links detailed time and cost values to 5D building models. The ITCMS enhances team coordination, automates estimating processes, and creates baselines for EVM reporting, thus improving construction productivity and performance. Ongoing research aims to enhance its capabilities further by integrating additional parameters like risk, quality management, and facility management.

Smith (2016) suggested that BIM can lead to cost savings and improved project outcomes. The 3D visualisation and collision detection capabilities of BIM enable efficient coordination of drawings and models, facilitating better construction planning and integration of complex interfaces. The study recommends six effective uses of BIM, emphasising that project staff and managers must understand its capabilities. Recommendations include monitoring project progress, recording issues identified through BIM, and allocating specific budgets for BIM. Additionally, forming internal BIM evaluation teams can enhance cost management and project outcomes. The research also identifies the challenges faced by cost management professionals when using BIM, including poor model quality, limited access, and software compatibility. Successful firms demonstrate strong leadership and proactive approaches, with recommendations to improve the effectiveness of BIM in cost management. Furthermore, Fazeli and Dashti (2021) propose an integrated BIM-based cost estimation approach to improve the accuracy and efficiency of decision-making during the design phase. This approach links MasterFormat and UniFormat standards to local cost estimation standards, resulting in quicker, more precise estimates. Despite potential challenges like reworks and change orders, the study demonstrates the approach's effectiveness in accurately evaluating design scenarios. The benefits include the traceability of cost changes, automation of the cost estimation process, and reduced dependency on experienced estimators.

Du (2021) explored the use of AI and BIM to develop a construction project cost simulation system, combining BIM with pricing data for early-stage cost management. The study highlights the role played by BIM in reducing information redundancy and improving stakeholder communication through digital models. Similarly, Shehab and Abdelalim (2023) examined the impact of BIM on cost estimation and control, linking cost data directly to building models. Their case study demonstrates the effectiveness of BIM in reducing errors and increasing efficiency, with recommendations to integrate time and cost data into a unified platform for streamlined processes. Alsamarraie and Ghazali (2023) examined the advantages of implementing BIM in public construction projects. The research highlighted key issues facing the industry, such as project delays, budget overruns, and poor quality, often exacerbated by bureaucratic inefficiencies. Through a quantitative analysis of two public construction projects and interviews with 15 industry experts, the research found that BIM significantly improves cost efficiency compared to traditional methods. The study concludes that BIM can lead to cost reductions, better project delivery, and enhanced quality, with the authors urging its broader implementation within government organisations to streamline processes and improve outcomes. Lastly, Pishdad and Onungwa (2024) explored how 5D BIM enhances cost management in construction projects. The study emphasised integrating 5D BIM with progress monitoring tools and payment systems to improve cost estimation and control. The challenges identified included limited interoperability when using traditional systems and a lack of standardised model elements. The study highlighted the potential of advanced technologies like AI and laser scanning to automate cost processes and improve efficiency. A case study demonstrated the effectiveness of 5D BIM in the pre-construction phases for cost visualisation and budget control, with standardisation advocated to optimise cost management practices.

2.3. Research gap and study positioning

The reviewed literature highlights different aspects of soft costs in construction projects and the cost implications associated with BIM implementation. Researchers have identified various soft costs in green building projects, such as insurance, developer experience, design expenses, certification, commissioning, and energy modelling. The emphasis on understanding these costs underscores the need to address the green cost premium to encourage sustainable construction practices. In BIM-based construction projects, leveraging BIM has been shown to reduce costs and improve project outcomes through advanced 3D visualisation, collision detection, and efficient coordination of drawings and models. Researchers have extensively explored the cost management potential of BIM, highlighting its ability to enhance design quality, reduce rework, and foster better stakeholder collaboration. Integrated BIM-based approaches for cost estimation have demonstrated improved accuracy and efficiency in the decision-making process during the design phase. However, persistent challenges remain, such as reworks, change orders, and limited interoperability with traditional systems.

Although prior research provides valuable insights into the general cost benefits of BIM, there is a notable gap in the literature. Research has primarily examined direct construction or BIM-associated costs in a broad sense, with little attention given to soft costs in BIM-based construction projects. To address this gap, this study aimed to investigate the factors affecting soft costs in BIM-based construction projects, using Malaysia as a case study. By investigating these factors, the author seeks to provide a comprehensive understanding of the financial implications of BIM, thereby contributing to more effective cost management and decision-making in the construction industry. Addressing this research gap would lead to the development of more precise BIM-specific cost management strategies, enhancing the accuracy of financial assessments and decision-making processes. The findings support the creation of comprehensive frameworks and guidelines that would facilitate the broader adoption of BIM, inform policy development, and improve the cost-efficiency of BIM implementation in the construction industry. Additionally, this study should encourage a greater academic focus in the future on the soft costs of BIM, which would enhance cost management within BIM-based construction projects.

3. Methodology

The topic of soft costs in BIM projects remains relatively underexplored (Azizi et al., 2018). The factors influencing soft costs in BIM-based construction projects represent a complex and multifaceted area, necessitating thorough investigation. To address this gap and gain comprehensive insights, a qualitative research strategy was employed because this approach is regarded as suitable for exploring real-life practices and experiences, thereby offering a nuanced understanding of the subject matter. The research methodology is illustrated in Fig. 1, which outlines the sequential steps involved in the study. The process commenced with the formulation of the study aim and the development of the interview protocol, including the creation of the interview questions. Subsequently, interview data was collected through open-ended questions, followed by the respondents' validation process. Finally, the data analysis section details how thematic analysis was used to identify the factors affecting soft costs in BIM-based construction projects.

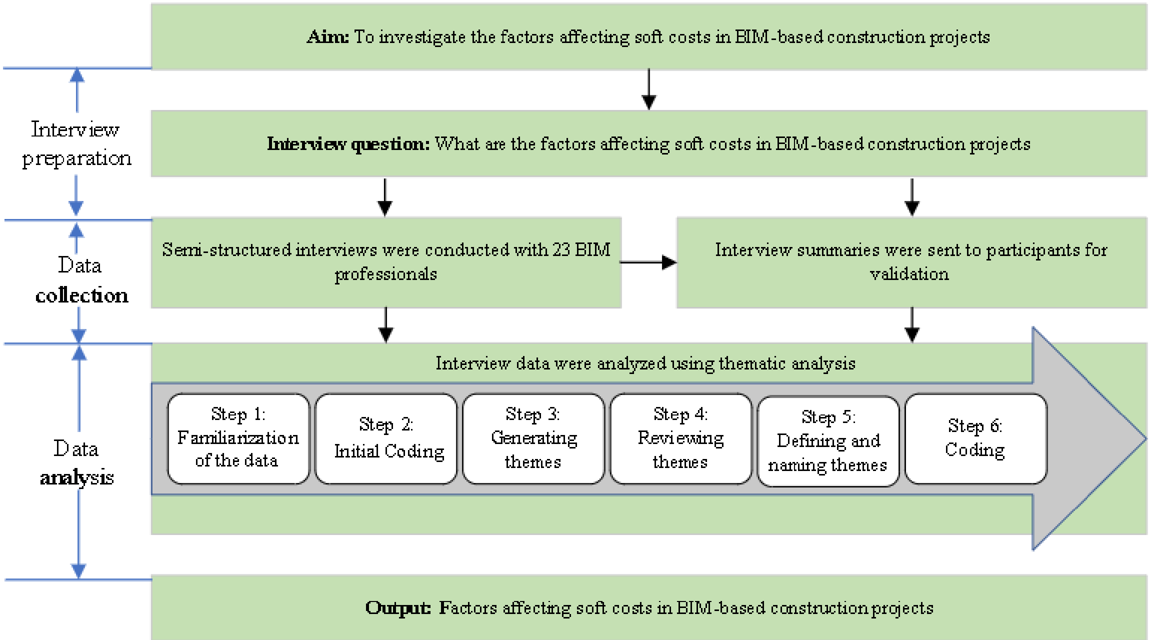

Fig. 1. Research methodology

3.1. Interviews

This study adopted a qualitative research strategy, utilising semi-structured interviews with BIM professionals to gather valuable insights into the factors affecting soft costs in BIM-based construction projects. This type of interview was chosen for its effectiveness in delving into the perspectives, experiences, and challenges faced by industry experts, as evidenced in prior research (Bunjaridh et al., 2023; Rani et al., 2022). Semi-structured interviews offer a balanced framework that allows the interviewer to explore specific topics while also providing the flexibility for participants to express their insights comprehensively (Magaldi and Berler, 2020). This methodological approach aligns with the aim of understanding the factors influencing soft costs in BIM-based projects. Drawing from established literature and industry practices, a targeted interview question was meticulously crafted: “What factors influence soft costs in BIM-based construction projects?” This question served as the focal point of the interviews, guiding the discussions towards a detailed exploration of the key elements impacting project costs in BIM environments.

To ensure a structured and productive interview process, an interview protocol was developed. This protocol acted as a roadmap, outlining the objectives, themes, and structure of the interview sessions (Papadonikolaki et al., 2022). The protocol emphasised voluntary participation, respect for interviewee autonomy, and open communication, allowing participants to raise queries or concerns before their interview. This approach fostered a transparent and collaborative environment, aimed at eliciting rich and relevant data. The interviews were conducted online using platforms like Google Meet and Microsoft Teams, offering the participants flexibility. The interviews varied in duration based on availability, with the average length being 30 minutes. The interviews were recorded only with each participant’s consent, and the recordings were analysed to extract insights into the factors affecting soft costs in BIM-based projects. Data was collected from 23 BIM professionals, including BIM Managers, BIM Coordinators, and those in other senior roles, whose average experience was over nine years. This lengthy average experience indicated a high level of expertise in the BIM field. The range of roles, from Assistant BIM Managers to BIM Directors/Senior Project Managers, ensured a broad spectrum of perspectives on BIM-related soft costs.

Table 1 presents data from the 23 targeted respondents, who were BIM experts. The majority of the respondents held positions as BIM Managers.

Table 1. Respondent profile

Code	Gender	Highest Academic Qualification	Position	Experience in the construction industry (years)	Experience in BIM (years)
R1	M	Bachelor of Civil Engineering	Assistant BIM Manager	10	8
R2	M	Diploma in Architecture	BIM Manager	12	10
R3	M	Bachelor of Civil Engineering	BIM Manager	13	12
R4	M	Master of Civil Engineering	BIM Manager	14	13
R5	M	Diploma in Civil Engineering	BIM Manager	12	12
R6	M	Master of Science	BIM Manager	20	17
R7	M	Bachelor of Civil Engineering	BIM Manager	16	16
R8	M	Master of Architecture	BIM Manager	10	9
R9	M	Diploma in Architecture	BIM Manager	11	11
R10	M	Bachelor of Civil Engineering	BIM Manager	14	12
R11	F	Master of Architecture	BIM Manager	9	7
R12	M	Bachelor of Civil Engineering	BIM Manager	12	12
R13	M	PhD in Civil Engineering	BIM Director	20	15
R14	M	Bachelor of Civil Engineering	BIM Manager	8	6
R15	M	Bachelor of Civil Engineering	BIM Manager	5	5
R16	M	Diploma of Civil Engineering	BIM Coordinator	5	3
R17	M	Master of Science	BIM Manager	12	12
R18	M	Master of Civil Engineering	BIM Manager	10	10
R19	M	Master of Architecture	BIM Manager	7	6
R20	M	Bachelor of Civil Engineering	BIM Manager	9	8
R21	F	Master of Architecture	BIM Manager	7	7
R22	M	Bachelor of Civil Engineering	BIM Coordinator	5	4
R23	M	Master of Architecture	BIM Manager	15	14

3.2. Data collection

The data collection process involved conducting semi-structured interviews with 23 BIM professionals, who were individuals with hands-on experience and specialised expertise in utilising BIM in the construction industry. To ensure the participants had the relevant expertise, the selection process was carefully conducted using LinkedIn profiles. Each candidate's profile was thoroughly reviewed to confirm their BIM experience and qualifications, ensuring the inclusion of participants who could provide valuable insights for the study. This participant selection method is known as purposive sampling, a non-random technique that targets individuals with the most relevant knowledge and experience for the research (Campbell et al., 2020). Purposive sampling focuses on gathering data from experienced professionals rather than adhering to a specific number of participants, ensuring that only those with the necessary BIM expertise were chosen for the study. This approach aligns with prior research that also targeted BIM professionals (Farouk and Rahman, 2023), reinforcing the credibility and relevance of the data collected. Open-ended questions were asked during the interviews to encourage detailed responses and extract a comprehensive amount of information from the participants. The purposive sampling method ensured that the data was collected from individuals with direct experience and in-depth knowledge of BIM who could contribute valuable perspectives on the factors affecting soft costs in BIM-based construction.

The interview process commenced with an introductory phase, in which the purpose of the interview and the topics to be covered were outlined. The participants were then presented with the primary interview question, with subsequent questions tailored based on their responses. The follow-up questions were designed to ensure clarity and deepen the understanding of the information shared by the participants. Where a participant did not provide a direct response or additional information, the interviewer rephrased the question and allowed sufficient time for a response. Participants were encouraged to elaborate on their responses and continue sharing insights as needed. Following each interview, a summary was prepared and shared with the participants for validation. This validation step ensured the accuracy and completeness of the gathered information. Data saturation was reached after conducting interviews with the twenty-third participant. Data saturation signifies the point in qualitative research where further data collection is unlikely to yield new insights (Farouk and Rahman, 2023). It serves as an indicator of the sufficiency of the data sample size, indicating that additional interviews would not significantly contribute new information or insights.

3.3. Data analysis

Thematic analysis, a highly suitable approach for interpreting qualitative data (Clarke and Braun, 2014), was employed to identify the factors affecting soft cost in BIM-based construction projects. This method has been widely recognised and used in construction management research for its effectiveness in revealing underlying themes and patterns (Farouk et al., 2021). Thematic analysis, being exploratory in nature, enabled a comprehensive exploration of the factors influencing soft costs without imposing preconceived frameworks or biases. During thematic analysis, the development of themes was flexible, relying on the researchers' expertise to unveil critical insights related to soft cost determinants. The six phases outlined by Clarke and Braun (2014) guided the thematic analysis process.

[1] Familiarisation with the data: The researchers reviewed the data by reading and rereading the responses to understand the factors influencing soft costs, with initial ideas noted. The interview summaries were then gathered to be read and reread to understand the variables and become more familiar with the data.
[2] Generating initial codes: The summary data was coded to identify potential themes. The codes were regularly reviewed and refined to ensure their relevance and accuracy.
[3] Searching for themes: The initial codes were divided into themes, revisiting the data to ensure that the identified themes were accurate and meaningful. The themes should reflect the nature of the data.
[4] Reviewing Themes: The themes were reviewed to ensure they captured all the relevant factors. This step involved revisiting the data to check that the themes were comprehensive.
[5] Defining and naming themes: Each theme was clearly defined and named. The researchers refined the themes to ensure they accurately reflected the data. The themes were then finalised before the last phase of the thematic analysis.
[6] Reporting the findings: The final phase involved reporting the identified themes and factors influencing soft costs in BIM-based construction projects.

4. Results

Fig. 2 illustrates the results of the thematic analysis, which are categorised under two themes. The first is organisational factors, which include salaries, the effective rate, the level of BIM implementation, and meetings. Meanwhile, the project factors include the design, project duration, client negotiations, construction site location, and on- and offsite activities. Table 2 provides descriptions of, and direct quotes linked to, the factors affecting soft costs in BIM-based construction projects. These descriptions explain how each factor affects soft costs. The theoretical framework, illustrated in Fig. 3, provides a categorisation of factors influencing soft costs in BIM-based construction projects; these were structured into two main subthemes: organisational factors and project factors. Each factor is interconnected, emphasising the dynamic interplay between organisational and project-specific influences. For example, salaries and the effective rate directly link to the project duration and team composition, while the site location affects logistical considerations that refer back to organisational decision-making processes. The framework highlights the multidimensional nature of soft costs, showcasing how organisational strategies and project-specific decisions collectively determine the financial outcomes and operational efficiency of BIM-based projects. This categorisation forms the foundation for understanding the discussion presented in the subsequent sections.

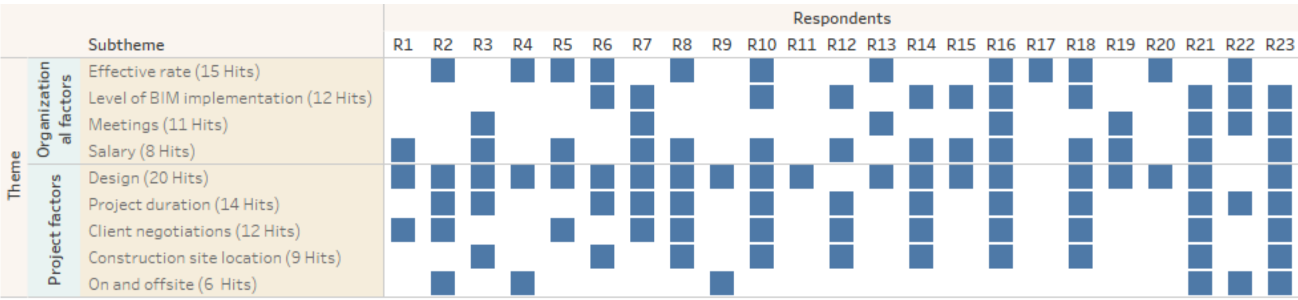

Fig. 2. Thematic analysis results

5. Discussion

5.1. Organisational factors

Under the organisational factors, several key elements emerged from the thematic analysis as critical factors influencing soft costs in BIM-based construction projects. These factors include salary considerations, the effective rate, the level of BIM implementation, and the number of meetings. Each plays a significant role in shaping soft costs and their impacts on project efficiency and outcomes.

5.1.1. Salary

The salary of BIM staff, a critical factor influencing soft costs, was categorised under organisational factors. Although salary itself is not a soft cost, it affects these costs indirectly through different mechanisms. Larger teams and multiple ongoing projects typically lead to higher soft costs because the number of staff impacts overall expenses (Fateh and Aziz, 2021). Several factors influence the salaries of BIM professionals, including the project type, sector, team size, budget, delivery systems, interoperability, and BIM maturity level. The competency requirements for BIM roles vary, encompassing management, technical, and personal skills. The implementation of BIM involves technical, human, economic, management, and legal aspects, all of which affect the barriers to and overall cost implications of BIM (Gao et al., 2024). Experience levels are also crucial; for example, a BIM modeller generally has 1-2 years of experience, a BIM coordinator typically has 3-4 years, and a BIM manager requires at least five years of experience. These experience levels influence not only salary expectations but also the overall efficiency and effectiveness of BIM implementation within an organisation. In summary, salary levels are a significant factor influencing soft costs in BIM-based construction projects.

5.1.2. Effective rate

The effective rate, alongside salaries, is a pivotal factor that significantly influences soft costs in BIM-based construction projects. Unlike salaries, which tend to be more uniform, the effective rate exhibits considerable variability across different companies (Williams, 2015). This metric reflects the actual amount an employee receives after accounting for all taxes, insurance, and other withholdings from their gross salary. It is essential to calculate the net income received by employees after all deductions. For BIM consultant organisations, the effective rate indicates the cost of completing each project, especially when employees are involved simultaneously in multiple projects. For instance, if a BIM coordinator at Organisation A manages two projects concurrently, their effective rate would be 0.5. Conversely, if a coordinator at Organisation B handles three projects at once, their effective rate would be 0.33. The interviews with industry experts reveal that this variance in the effective rate underscores the different ways that companies manage project workloads and the subsequent impacts on soft costs. The respondents reported effective rates ranging from 1 to 0.3, highlighting the significant influence of workload distribution on soft costs in BIM-based projects. Table 2 presents direct quotes regarding the effective rate.

Table 2. The descriptions and direct quotes for the factors affecting soft cost in BIM-based construction projects

Subtheme	Description	Direct quotes
Theme: Organizational factors		
Salary (FA1)	Employee pay based on role and experience, usually agreed upon in contracts.	"Salaries differ based on experience... BIM modeler (1-2 years), BIM coordinator (3-4 years), BIM manager (5+ years)." R23.
Effective rate (FA2)	Efficiency measure aligning employee salary with productivity and project handling.	"Higher BIM levels reduce soft costs by minimizing errors and improving coordination. Initial levels increase costs due to manual errors, while advanced levels achieve seamless integration." (R7)
Level of BIM implementation (FA3)	Depth of BIM use, from 2D to full lifecycle integration.	"Higher BIM levels reduce soft costs... Lower levels (0-1) have more errors; higher levels (4-5) reduce errors and costs." R7.
Meetings (FA4)	A monthly meeting at the construction site for BIM updates, team coordination, design reviews, clash resolutions, and others	" The number of meetings differs from one to three meetings per month or per two months depending on the project complexity, client requirements and project location.” (R19)
Theme: Project factors		
Design (FA5)	Process of creating and managing 3D models for coordination of systems.	" Design challenges, such as coordination issues and clashes between systems, lead to delays, rework, and additional costs for meetings, materials, and schedule adjustments.” (R9)
Project Duration (FA6)	Total time from start to project completion.	Longer project durations can increase soft costs in several ways. For instance, having different BIM staff members involved in each phase, with varying salaries and expenses, can drive up costs throughout the project lifecycle." (R3)
Client negotiations (FA7)	Discussions on project scope, budget, timelines, and resources between clients and consultants.	"Clients focus on the multiplier, resources, and project duration. The multiplier directly influences consultant costs, while the number of engineers involved impacts project efficiency and timelines." (R9) "Clients seek to minimize project duration, by hiring part-time BIM coordinators for onsite work." (R17)
Construction site location (FA8)	Geographical location of the project.	"Sites in areas with higher labor costs or limited skilled workers will face increased expenses for labor. Also, remote locations can lead to higher costs for transporting materials" R18.
On and offsite (FA9)	Activities conducted at or away from the site.	"The onsite impacts the multiplier value, which increases it in comparison with offsite" R11.

5.1.3. Level of BIM implementation

The level of BIM implementation is a crucial factor affecting soft costs and was categorised under organisational factors. As companies advance through different BIM levels, the impacts on the soft costs associated with project design, development, and management become increasingly significant. At Level 0, which is characterised by minimal collaboration and reliance on 2D CAD drafting, soft costs may initially be lower due to simpler data exchange methods. However, this can lead to inefficient design coordination and information sharing, potentially increasing the soft costs over time as the project grows in complexity. Progressing to Level 1, which involves a combination of 3D CAD for conceptual work and 2D CAD for approvals, soft costs may start to decrease. Improved collaboration and data sharing, facilitated by standards like BS 1192:2007 and the use of a common data environment (CDE), help to reduce errors and rework, thus lowering the soft costs. At Level 2, where collaborative working with 3D BIM models is established, soft costs generally decrease further. The ability to share 3D models via a CDE and the adherence to common formats like IFC can enhance coordination and communication among stakeholders, leading to more efficient workflows and reduced soft costs. Level 3 represents the peak of BIM implementation, with centralised models and integrated systems offering advanced functionalities such as 4D scheduling, 5D cost estimation, and 6D life cycle management (Robin and Yahya, 2023). At this level, soft costs are significantly reduced due to improved project coordination, data accuracy, and decision-making capabilities, which are enabled by comprehensive BIM integration. For specific direct quotes related to BIM levels, see Table 2.

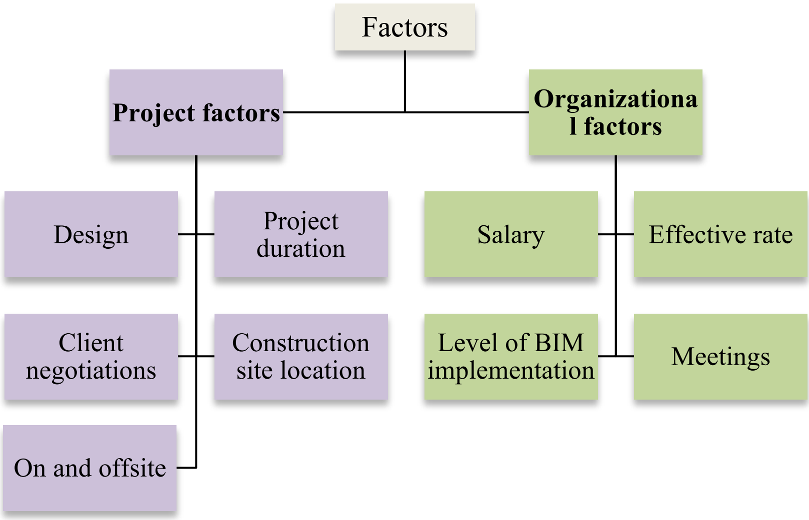

Fig. 3 . Theoretical framework

5.1.4. Meetings

The number of meetings is a critical factor affecting soft costs in BIM-based construction projects and was categorised under organisational factors. This categorisation can be justified by this factor's considerable variation across different companies, although it could also be relevant to multiple categories. Meetings, whether held within a project area or at external locations like hotels, significantly impact different elements that contribute to soft costs in BIM-based projects. For instance, the frequency of meetings directly affects mileage costs; more frequent meetings necessitate increased travel for project participants, resulting in higher mileage expenses. This encompasses travel to and from meeting venues, which can mean the accumulation of significant costs for projects distributed over large geographical areas. Additionally, accommodation costs become a factor, especially for meetings conducted outside a project area. Companies might need to arrange lodging for participants travelling from distant locations, incurring extra expenses like hotel bookings, meals, and other incidental costs related to overnight stays. Furthermore, the number of meetings influences telecommunication costs. A higher frequency of meetings typically means a greater demand for telecommunication services such as conference calls, video meetings, and virtual collaboration tools, which often involve usage fees and subscription costs. Consequently, these services contribute to the project's overall telecommunication expenses. In summary, the number of meetings impacts soft costs in BIM-based construction projects by influencing mileage expenses due to increased travel, accommodation costs for external meetings, and telecommunication costs related to facilitating effective communication and collaboration among project stakeholders (Yang et al., 2011).

5.2. Project factors

5.2.1. Design

Design is a significant factor affecting soft costs in BIM-based construction projects and was categorised under project factors. Coordination challenges within the design phase, such as clashes between different building systems, can result in substantial additional expenses for resolution meetings, redesigns, and coordination efforts. These coordination issues often lead to delays and rework, which subsequently increase the soft costs associated with labour and management. Additionally, changes and revisions to the design during the construction phase can further escalate soft costs. Such alterations may necessitate additional materials, schedule adjustments, and further coordination efforts, leading to increased expenses. The clash detection and resolution capabilities of BIM are crucial for mitigating these soft costs. The early identification of clashes between architectural, structural, and MEP systems enables proactive resolution, reducing the need for rework and change orders. This proactive approach not only saves time but also minimises costly modifications, resulting in significant soft cost savings (Akponeware and Adamu, 2017). Moreover, the complexity of design details and unconventional elements can impact soft costs. Complex designs often mean that more time is required for modelling, coordination, and communication among project stakeholders, which contributes to higher soft costs related to labour and management. Efficient design processes, coupled with proactive clash detection and resolution strategies, are essential for managing soft costs effectively in BIM-based construction projects. By addressing coordination challenges early, minimising design changes, and leveraging the clash detection capabilities of BIM, projects can achieve cost savings and improved outcomes.

5.2.2. Project duration

The project duration significantly influences soft costs in BIM-based construction projects and was categorised under project factors. The duration spans all phases of a project—pre-construction, construction, and post-construction. The involvement across these phases of different BIM staff members, each of whom has distinct salaries and associated expenses, directly impacts soft costs throughout the project life cycle. Key aspects that are influenced by project duration are insurance and professional costs. Extended project timelines often lead to higher soft costs related to insurance, including coverage for project completion, performance and payment bonds, liability insurance, and sub-guard policies. These additional costs arise from the need for ongoing coverage and risk management throughout the project's prolonged duration. Moreover, the spread of soft costs over the entire construction timeline, extending beyond the construction phase, presents challenges in predicting and estimating these expenses compared to hard costs. Soft costs are more variable and ongoing, which can significantly impact the overall project budget if not managed and accounted for (Lindblad and Guerrero, 2020). A longer project duration also contributes to the accumulation of additional soft costs, such as ongoing fees, increased financing expenses, higher management and administration costs, as well as elevated insurance and professional costs. BIM managers must meticulously account for these factors in their planning and estimation processes to ensure that projects adhere to budget constraints and scheduled timelines. Table 2 lists direct quotes on project duration.

5.2.3. Client negotiations

Client negotiations are a significant factor influencing soft costs in BIM-based construction projects and were categorised under project factors. This factor impacts soft costs due to its variability and direct influence on project expenses, making them challenging to predict and calculate accurately. During negotiations, clients focus on key aspects that directly affect soft costs: the multiplier, resources, and project duration. The multiplier, which ranges from 1 to 2.7, is crucial in determining consultant costs. A higher multiplier corresponds to higher consultant fees, which directly impacts soft costs, while a lower multiplier may lead to reduced profit margins for the BIM consultant. Additionally, negotiations about resources, such as the number of engineers involved, their roles (onsite or offsite), and their availability, influence a project's efficiency and timelines. This allocation of resources affects soft costs through labour expenses and project duration. Clients also prioritise minimising the project duration during negotiations. This focus often results in strategies like hiring part-time BIM coordinators for onsite work to ensure continuity within BIM teams while optimising costs. Negotiations commonly involve discussions about lump sum agreements, resource allocation, and reimbursable fees. Clients scrutinise these elements to optimise project costs, with soft costs sometimes significantly impacted by the negotiated terms. The variability and complexity of client negotiations underscore their significant impact on soft costs in BIM-based construction projects. Effective negotiation strategies, clear communication of project requirements, and transparent cost discussions are essential to managing soft costs effectively during client negotiations (Lindblad and Guerrero, 2020).

5.2.4. Construction site location

The location of a construction site is a pivotal factor influencing soft costs within BIM-based construction projects and was categorised under project factors. The site location impacts soft costs through different mechanisms related to regulatory requirements, labour costs, material accessibility, and infrastructure needs. Different site locations are subject to varying regulatory requirements, including permits, environmental assessments, and zoning regulations, which can directly impact soft costs. These regulations often necessitate additional planning, documentation, and compliance measures, leading to increased expenses. Additionally, sites situated in areas with higher labour costs or a scarcity of skilled workers experience elevated soft costs related to labour expenses. Remote or challenging locations pose further challenges in accessing construction materials. The difficulty of transporting materials to such sites results in higher soft costs due to increased transportation, storage, and procurement challenges. Sites on difficult terrain, or those with environmental sensitivities or unique geological conditions, may require specialised assessments, mitigation measures, or modifications. These factors contribute to increased soft costs related to site preparation and risk management. Moreover, access to utilities such as water, electricity, and gas, as well as the existing infrastructure, significantly influences soft costs. Establishing temporary services, connecting utilities, and upgrading the infrastructure to meet the project needs all add to the overall expenses. The distance of a site from the organisation's base is also crucial because longer distances lead to higher transportation and logistics costs. This highlights the importance of considering the site proximity in cost management strategies (Parameswaran et al., 2019).

5.2.5. Onsite and offsite

The location of work activities—whether onsite or offsite—significantly influences soft costs in BIM-based construction projects; this was categorised under project factors. Onsite work introduces unique challenges and costs compared to offsite work, impacting different aspects of project management and budgeting. Firstly, onsite work can affect the effective rate as it may prevent staff from working on multiple projects simultaneously. This limitation potentially reduces overall productivity and efficiency, contributing to higher soft costs. Onsite projects may also require additional resources and considerations, such as providing specialised hardware, software, and medical coverage for onsite staff. These requirements further increase the soft costs associated with equipment and health provisions. Staff allocation is another crucial factor that is influenced by onsite work. Companies might need to hire specific BIM professionals tailored to the client's onsite project needs, resulting in adjustments to staffing levels and resource allocation strategies. This can lead to increased costs related to recruitment and personnel management that enable the project demands to be met effectively. Client requirements play a significant role in determining the mode of work. Clients often aim to minimise the project duration and may prefer onsite work to facilitate closer collaboration and communication. This onsite preference can lead to further considerations around optimising project costs while maintaining quality and efficiency. To manage soft costs effectively, companies might adopt different optimisation strategies, including hiring part-time onsite staff or negotiating agreements with clients to optimise costs while ensuring project quality. Discussions about lump sum agreements, resource allocation, and reimbursable fees are common, with a focus on aligning the project outcomes with budget constraints. For detailed direct quotes from interviews, refer to Table 2.

5.3. Study implications

5.3.1. Practical implications

For industry professionals, a deep comprehension of these soft cost factors is crucial for effective cost management and strategic investment decisions. Accurate assessment of the financial impacts of BIM implementation—encompassing development charges, certification fees, commissioning fees, contingency fees, levy fees, and documentation fees—is essential for determining the ROI of BIM. Companies must also account for the ongoing costs associated with the maintenance and updating of BIM models, which impact the long-term ROI. By clarifying these costs, organisations can make informed decisions that justify their initial investment in BIM and demonstrate its financial benefits. Furthermore, this knowledge can help address and mitigate resistance to BIM adoption by highlighting its potential for cost savings and efficiency improvements. For instance, recognising the impact of BIM on reducing rework, improving coordination, and minimising errors can make a compelling case for its value to stakeholders and decision-makers.

5.3.2. Theoretical implications

From an academic perspective, understanding soft costs facilitates the development of comprehensive frameworks to evaluate the financial performance of BIM projects. Researchers can leverage this knowledge to create detailed analyses of different fees and ongoing costs, which are critical for the development of national BIM guidelines and policies. This, in turn, supports the broader adoption and standardisation of BIM practices within the industry. Integrating these insights into educational programs equips future professionals with the skills and knowledge required to manage BIM-based projects effectively. By incorporating practical case studies and real-world examples of soft cost management into their curricula, educational institutions can better prepare students to address the financial challenges associated with BIM, thereby enhancing their readiness for the workforce.

6. Conclusion

This study aimed to investigate the factors affecting soft costs in BIM-based construction projects, using Malaysia as a case study. To achieve this, data was collected through interviews with 23 BIM professionals, and thematic analysis was employed to analyse the collected data. The findings revealed that these factors could be categorised into two themes: organisational factors and project factors. Understanding these factors could help determine the ROI of BIM, promoting more BIM implementation across developing countries. This study contributes to the existing knowledge by highlighting the factors affecting soft costs in BIM-based construction projects, and it adds to the body of literature on soft costs in the BIM context. Despite the valuable insights gained from this study, there are several limitations to consider. Firstly, the findings may not fully represent the sociotechnical context of BIM-based construction projects worldwide as the study's participants were exclusively from Malaysia. The factors affecting soft costs in BIM projects may differ significantly across different countries due to the diverse economic, regulatory, and cultural contexts. Future researchers could expand the sample size to address this limitation. Secondly, this research focuses solely on identifying the factors influencing soft costs. Future research should extend this by examining the cost implications and challenges associated with these factors, as well as exploring other elements that contribute to the overall ROI of BIM. Lastly, the primary motivation being this study was to assist in determining the ROI of BIM. It is important to recognise that soft cost factors are only one aspect of this broader evaluation; other aspects should also be investigated to provide a comprehensive understanding of the ROI of BIM. Future studies should aim to integrate these diverse variables to offer a more comprehensive assessment of the ROI of BIM in construction projects.

Acknowledgement

The authors are grateful to the professionals in the construction industry who took part in the interviews and the editors and anonymous reviewers for their insightful comments, helping to improve the quality of this manuscript.

Author Contributions

Abdelrahman contributes to methodology, data collection, draft preparation and manuscript editing. Ahmad Tarmizi and Eleni contribute to supervision and project administration. Rahimi contributes to conceptualization, supervision, validation, and manuscript editing. All authors have read and agreed with the manuscript before its submission and publication.

Funding

This work is supported by Universiti Malaysia Pahang Al-Sultan Abdullah (RDU223314).

Institutional Review Board Statement

Not applicable

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