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BIM CONSULTANCY COST FORMATION IN DESIGN-STAGE PUBLIC PROJECTS: EVIDENCE FROM VIETNAM

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ABSTRACT

This study examines the structure and estimation of Building Information Modelling (BIM) consultancy cost estimates in public construction projects. While BIM adoption is expanding rapidly, limited empirical evidence exists on how BIM-related costs are structured in practice, particularly in consultancy-driven project environments. Using a multiple case study approach, the research analyses BIM consultancy cost estimation reports from four public construction projects in Vietnam, focusing on design-stage implementation. The study investigates the composition of BIM consultancy costs, the allocation of BIM personnel roles, and the factors influencing cost estimation practices. The findings indicate that BIM cost estimates are primarily driven by labour inputs associated with BIM managers, coordinators, and modellers, while software licences and technical resources constitute a relatively small share of the overall consultancy budget. The results further show that project complexity, implementation stage, procurement arrangements, information requirements and scope specification significantly influence BIM cost estimation. By providing empirical evidence derived from approved cost estimation documents used in project planning, this study contributes to a clearer understanding of BIM cost estimation structures as governance-dependent processes and offers practical insights for project owners planning BIM implementation in consultancy-driven construction environments.

Keywords: *BIM; BIM implementation cost estimation; BIM team structure; Construction cost estimation; Public construction projects.*

1. INTRODUCTION

BIM has become a central component of digital transformation in the global Architecture, Engineering and Construction (AEC) industry. Rather than a standalone software tool, BIM functions as an integrated information management process supporting collaboration across the lifecycle of built assets (Borrmann et al., 2018; Sacks et al., 2018). Numerous studies indicate that BIM can improve interdisciplinary coordination, reduce design conflicts and enhance project transparency, thereby contributing to improved project performance and lifecycle value (Azhar, 2011; Bryde et al., 2013; Lu et al., 2014). Consequently, many governments have introduced policies encouraging or mandating BIM adoption in public construction projects as part of broader digitalisation strategies for the built environment. Alongside these global developments, emerging

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construction markets have also promoted BIM adoption in public construction projects. However, BIM implementation remains uneven, particularly due to uncertainties regarding the estimation of costs associated with BIM implementation during project planning stages (European Commission, 2021; Gharaibeh et al., 2024).

In Vietnam, BIM adoption has been supported by an evolving regulatory framework. The government approved a national BIM roadmap and subsequently established mandatory BIM application requirements for specified categories of construction projects (Government of Vietnam, 2024). In parallel, construction investment cost management is regulated by Decree No. 10/2021/ND-CP, which defines the structure of project cost estimates and the role of consultancy services in determining construction investment costs (Government of Vietnam, 2021). Within this framework, BIM implementation in many projects is typically delivered through consultancy services and incorporated into project cost estimates (Ministry of Construction, 2021). More recently, Circular No. 09/2024/TT-BXD provides explicit guidance on estimating BIM-related costs within consultancy services, including regulatory limits for BIM expenditures across project stages (Ministry of Construction, 2024).

In this context, BIM-related expenditures are primarily defined at the planning stage through cost estimation documents rather than reflecting actual project expenditures. Despite the recognised benefits of BIM, the financial implications and cost estimation practices associated with BIM implementation remain insufficiently understood because existing research has largely focused on the economic benefits of BIM adoption rather than the structure of BIM implementation costs (Bryde et al., 2013; Mitchell et al., 2023).

Comparatively fewer studies have examined how BIM implementation costs are structured and estimated during project planning. This gap is particularly relevant in consultancy-driven BIM implementation environments. In many emerging construction markets, including Vietnam, BIM services are frequently procured as specialised consultancy packages within public construction projects (Nguyen et al., 2021; Pham et al., 2024). In such contexts, BIM implementation costs are largely composed of labour inputs associated with BIM specialists, including BIM managers, BIM coordinators and BIM modellers, together with supporting costs such as software licences and computing infrastructure (Hardin & McCool, 2015; Kumar, 2015). As a result, BIM cost estimation is strongly influenced by assumptions regarding team composition, labour allocation and the scope of BIM activities across project phases.

Despite the growing integration of BIM within regulatory frameworks, empirical evidence on how BIM consultancy costs are structured in real construction projects remains limited. Existing studies rarely explain how BIM cost estimation is shaped by project-specific information requirements, procurement strategies, and institutional cost estimation frameworks. As a result, there is limited understanding of the mechanisms through which BIM consultancy cost structures are formed and formalised in practice.

To address this gap, this study investigates the structure and estimation of BIM implementation costs in public construction projects through multiple case studies in Vietnam. The research analyses BIM consultancy cost estimation documents and procurement records to identify key cost components and examine BIM personnel allocation within consultancy-based BIM services. Through cross-case comparison, the study explains how BIM consultancy cost estimates are formed under different implementation conditions, including Exchange Information Requirement (EIR)-driven information management, integrated design–BIM processes and Terms Of Reference (TOR)-based estimation approaches.

2. LITERATURE REVIEW

BIM has significantly transformed how construction projects are designed, coordinated and managed by enabling integrated information management across the lifecycle of built assets (Borrmann et al., 2018; Sacks et al., 2018). Through digital models integrating geometric and non-geometric information, BIM facilitates structured data exchange, interdisciplinary coordination, and improved decision-making (Ngo et al., 2020). In developing construction markets such as Vietnam, BIM has been increasingly promoted as a mechanism for improving productivity, coordination and information transparency in construction projects (Pham et al., 2024).

Despite these recognised benefits, existing research has focused primarily on performance improvements, such as reduced design conflicts and enhanced coordination, while comparatively limited attention has been given to the structure and estimation of BIM implementation costs (Bryde et al., 2013; Lu et al., 2014). This gap creates uncertainty for project owners when planning BIM adoption in real construction projects.

2.1 BIM IMPLEMENTATION COSTS

BIM implementation costs refer to the investments required to establish and operate digital modelling and information management processes throughout the lifecycle of a construction project (Sacks et al., 2018). These costs arise not only from technological investments but also from organisational changes associated with BIM-based workflows, including adjustments to coordination processes, data management practices and professional competencies (Borrmann et al., 2018; Hardin & McCool, 2015).

Existing studies identify key cost components, including labour inputs, software licensing, hardware infrastructure, staff training and digital information management systems such as Common Data Environment (CDE) (Borrmann et al., 2018; Hardin & McCool, 2015; Sacks et al., 2018). Labour costs are often reported as the dominant component, although empirical quantification remains limited (Lu et al., 2014).

In the Vietnamese context, BIM-related expenditures typically include modelling activities, software and hardware investments, training programmes and digital information systems (Nguyen, 2024; Pham et al., 2024). Empirical evidence suggests that BIM adoption may require additional upfront investment, despite potential improvements in cost estimation and quantity take-off (Mai et al., 2025). However, practical guidance on how BIM costs should be incorporated into project cost estimates remains limited.

Existing studies tend to conceptualise BIM implementation costs primarily as technical or resource-based expenditures, with limited attention to how these costs are shaped by project-specific information requirements, procurement strategies, and institutional cost estimation frameworks.

2.2 BIM CONSULTANCY SERVICES

In many construction markets, BIM implementation is delivered through specialised consultancy services rather than internal capabilities. BIM consultants provide expertise in modelling, coordination and information management, enabling project stakeholders to adopt BIM workflows (Hardin & McCool, 2015; Kumar, 2015).

Typical consultancy services include BIM modelling, interdisciplinary coordination and digital information management processes (Borrmann et al., 2018; Sacks et al., 2018). These services increasingly extend to advisory functions such as establishing modelling standards, managing data exchange protocols and operating CDEs (European Commission, 2021).

In emerging BIM markets such as Vietnam, consultancy firms play a central role in BIM implementation and industry diffusion (Nguyen et al., 2021).

2.3 BIM RESOURCE STRUCTURES

BIM implementation relies on specialised team structures involving BIM managers, BIM coordinators and BIM modellers (Barnes & Davies, 2014; Sacks et al., 2018). These roles correspond to strategic management, interdisciplinary coordination and technical modelling functions within BIM workflows (Hardin & McCool, 2015)

Labour inputs associated with these roles vary across project stages, with modelling concentrated in design phases and coordination extending throughout the project lifecycle (Lu et al., 2014). In Vietnam, BIM adoption also requires organisational adjustments and the development of digital competencies within project teams (Dao & Nguyen, 2021).

Despite this, limited research has examined how BIM personnel allocation translates into cost structures within consultancy contracts, particularly in terms of quantifying the contribution of labour and other cost components. As a result, project owners often face difficulties in estimating BIM costs based on team composition and project requirements. Furthermore, existing studies provide limited empirical evidence on how variations in information requirements, levels of integration with design processes, and institutional estimation norms influence BIM personnel allocation and resulting cost structures.

This study addresses this gap by using approved cost estimation documents to quantify how BIM consultancy costs are proportionally structured in practice. Through cross-case analysis, the study examines how BIM cost estimation is shaped by different implementation approaches, including EIR-driven information requirements, integration with design consultancy processes, and reliance on TOR-defined scope and standardised estimation norms.

Based on the reviewed literature, BIM implementation costs in consultancy-driven environments can be interpreted as a structured consultancy service pricing mechanism shaped not only by resource requirements but also by information governance processes and institutional cost estimation frameworks. As shown in Figure 1, BIM consultancy cost structures consist of direct resource costs (labour and technical resources) and indirect consultancy components (management costs, profit and taxes).

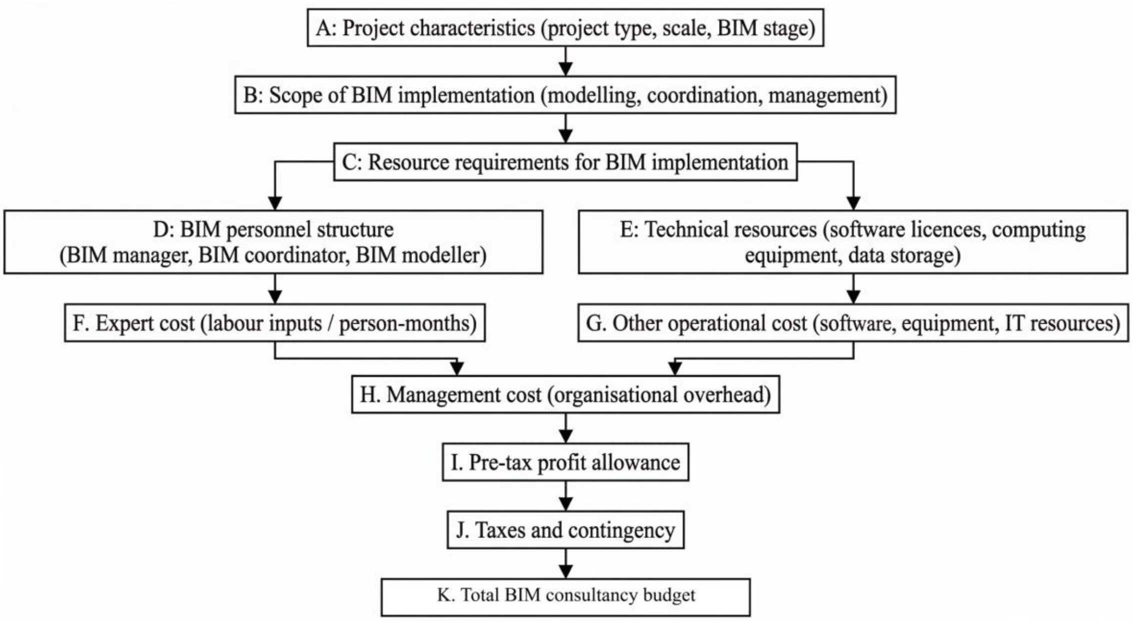

Figure 1: Structure of BIM consultancy cost estimation in consultancy-driven BIM implementation environments

This framework provides the basis for analysing BIM cost estimation as a governance-dependent and institutionally shaped process rather than a purely technical expenditure.

3. RESEARCH METHODOLOGY

This study adopts a multiple case study approach with document analysis to examine the structure and estimation of BIM implementation costs in public construction projects. Multiple case studies are particularly suitable for investigating contemporary phenomena within their real-world contexts and for identifying recurring patterns across cases (Yin, 2018). Document analysis provides a systematic means of examining organisational and project records to generate empirical insights from existing documentation (Bowen, 2009). The research focuses on identifying recurring patterns in BIM cost structures within consultancy-driven environments.

The empirical analysis is based on four public construction projects in Vietnam in which BIM implementation costs were formally estimated and approved as part of project consultancy packages. Given the limited number of cases, the study is intended to provide indicative insights into BIM cost estimation practices, not to generalise the findings. This limitation also reflects data accessibility constraints, as detailed cost estimation documents are not publicly disclosed in most cases. Publicly available procurement information, such as tender plans, typically reports only aggregated contract values rather than detailed cost breakdowns, which constrains large-sample empirical analysis of BIM cost structures in this context. These cases were selected based on three criteria: (1) BIM implementation was conducted within public construction investment procedures; (2) BIM-related costs were explicitly identified in project documentation, either as standalone consultancy packages or as components integrated within design consultancy services; and (3) sufficient documentation was available to analyse cost breakdown structures and BIM personnel allocations. The analysed documents include project approval decisions, BIM consultancy cost estimates, detailed cost breakdown tables, and appendices describing work scopes and professional inputs, providing information on project characteristics, cost components, and the organisation of BIM-related activities. The selected projects represent both standalone BIM consultancy packages and integrated design–BIM consultancy arrangements, as well as different levels of BIM scope specification, including EIR-driven implementation, task-based integrated BIM processes, and TOR-defined scope aligned with standardised estimation norms.

To analyse BIM implementation costs, the study applies an analytical framework consisting of three dimensions: BIM cost components, BIM personnel structures, and estimation factors influencing BIM consultancy costs. The first dimension examines how BIM cost components, such as labour inputs, software licenses, and technical resources, are represented within project cost estimates. The second dimension focuses on BIM personnel structures, particularly the roles of BIM managers, BIM coordinators, and BIM modelers and their allocation across project activities. The third dimension considers contextual and institutional factors influencing BIM consultancy cost estimation, including project characteristics, implementation stage, procurement arrangements, and the level of BIM scope specification (e.g., EIR-driven requirements, integration with design processes, and reliance on TOR-defined scope and estimation norms).

The analysis was conducted in two main stages. First, BIM-related information was identified and extracted from project documentation, including cost estimates, consultancy scopes, and references to BIM personnel roles. The extracted information was then organised according to the three analytical dimensions of the study: BIM cost components, BIM personnel structures, and BIM cost estimation factors. Second, within-case analysis was conducted to examine how BIM costs were structured and estimated in each project individually. This was followed by cross-case comparison to identify recurring cost patterns and differences in cost composition, labour allocation, and estimation approaches across the four cases. Such analytical procedures are consistent with established case study research methods that combine within-case understanding with cross-case pattern identification (Yin, 2018).

4. EMPIRICAL CASE CONTEXT

This study examines four BIM consultancy packages implemented in public construction projects in Vietnam. In the Vietnamese procurement system, BIM implementation is typically delivered as consultancy services and incorporated into design consultancy cost estimates. The anonymised analysed cases (Case A – Case D) were identified from officially approved BIM cost estimation documents issued for public investment projects.

The selected cases involve BIM implementation during the detailed design or construction drawing design stages. Case A and Case B represent standalone BIM consultancy packages focusing on modelling, coordination, and structured information management governed by formal EIR. In contrast, Case C and Case D represent integrated design–BIM consultancy packages in which BIM activities are embedded within broader design consultancy contracts. However, they differ in the level of scope definition and cost structuring: Case C reflects a detailed, task-based BIM implementation supported by EIR and TOR, whereas Case D represents a more standardised approach in which BIM scope is defined through TOR, yet cost estimation relies more heavily on predefined regulatory norms. Despite these differences, all cases require bidders to prepare and submit a BIM Execution Plan (BEP) as part of the procurement process. This distinction provides an analytical basis for examining BIM cost estimation across different levels of scope specification rather than fundamentally different procurement types. Table 1 summarises the key characteristics of the analysed cases.

Table 1: Characteristics of the analysed BIM consultancy cases

Case	Project category	Procurement arrangement	BIM consultancy scope	Estimated BIM services value
Case A	Public building project	Standalone BIM consultancy (EIR/BEP/CDE)	Modelling, coordination, CDE, BEP, data exchange	~ VND 1.71 billion
Case B	Public facility project	Standalone BIM consultancy (EIR-based)	Modelling, coordination, structured information management	~ VND 4.13 billion
Case C	Public hospital project	Integrated design–BIM consultancy	Task-based BIM (modelling, coordination, QTO, documentation)	~ VND 0.82 billion
Case D	Public hospital project	Integrated design–BIM consultancy	TOR-defined BIM, standardised estimation norms	~ VND 0.92 billion

Source: *Developed by the authors based on the BIM cases documentation*

The cases collectively illustrate how BIM services are delivered under different implementation logics. Cases A and B demonstrate EIR-driven standalone consultancy approaches, in which BIM implementation includes structured information management processes such as data exchange protocols and coordination governance. Cases C and D illustrate integrated design–BIM consultancy approaches, where BIM activities are embedded within design processes, with varying degrees of task specification and reliance on standardised estimation norms. The analysed documentation also shows that BIM implementation relies on specialised personnel roles, including BIM managers, BIM coordinators and BIM modellers. These roles extend beyond modelling to include coordination and information management functions, depending on project requirements.

The BIM consultancy cost estimation documents provide structured information on how BIM costs are calculated within the Vietnamese construction cost management framework. Despite variations in format, these documents consistently include: (1) total consultancy cost estimates, (2) labour cost breakdowns specifying personnel and working time, and (3) operational costs related to technical resources such as software and computing infrastructure. In Cases A and B, cost estimation reflects the inclusion of structured information management activities such as CDE setup and BEP development. In Cases C and D, cost estimation reflects the integration of BIM within design consultancy processes, with either detailed task-based allocation (Case C) or standardised estimation norms linked to TOR-defined scope (Case D). This empirical structure provides the basis for the analysis in the following section, which examines BIM consultancy cost structures and the factors shaping their estimation in practice.

5. RESULTS

5.1 STRUCTURE OF BIM CONSULTANCY COST

The analysis of the four cases suggests a broadly consistent structure in BIM consultancy cost estimation across the analysed projects. Despite variations in documentation formats, the estimation approach follows a standard consultancy pricing framework applied in the Vietnamese construction sector. Within this framework, BIM consultancy costs comprise expert costs, management costs, other operational costs, and contractual allowances such as pre-tax profit and taxes. Expert costs represent direct labour inputs, while management costs cover organisational overhead. Across the cases, labour inputs included activities related to modelling, coordination and information management.

In Case C, labour inputs are structured through detailed task-based BIM activities, whereas in Case D, cost estimation is aligned with TOR-defined scope but calculated using standardised regulatory norms. Other operational costs include technical resources, i.e. software licences and computing infrastructure. These findings show that BIM consultancy cost estimates include both modelling-related activities and information management functions within project delivery processes (refer Table 2).

Table 2: Structure of BIM consultancy cost components

Cost component	Description	Cost driver
Expert cost	Labour inputs associated with BIM managers, BIM coordinators and BIM modellers involved in project implementation	Team size, component and working duration
Management cost	Organisational overhead costs incurred by consultancy firms in managing BIM services	Share of expert cost and organisational structure
Other operational cost	Costs related to software licences, computing equipment and other technical resources required for BIM implementation	Technical resource requirements
Pre-tax profit	Profit allowance incorporated into consultancy service pricing	Contractual pricing structure
Taxes and contingency	Taxes and contingency allowances applied according to project financial regulations	Regulatory and contractual requirements

Source: *Developed by the authors based on the BIM cases documentation*

These components illustrate how BIM consultancy cost estimates are organised within approved project cost structures. Table 3 complements this structure with quantitative distribution of BIM cost components together with total labour input across the cases. The notation in the final column indicates the number of personnel and corresponding total labour input (person-days) for each role (e.g., 1(45)/3(135)/11(495) denotes 1 BIM manager with 45 person-days, 3 BIM coordinators with 135 person-days, and 11 BIM modellers with 495 person-days). Management costs mainly represent consultancy overheads, whereas other costs include software, computing infrastructure and related BIM operational resources.

Table 3: Indicative distribution of BIM consultancy cost estimates and labour input based on approved estimation documents

Case	Total BIM cost estimates (VND)	Labour (%)	Management (%)	Others (%)	Profit & Tax (%)	Total labour input (person/person-days)
A	1,711,706,000	53.69	29.53	4.38	12.40	1(45)/3(135)/11(495)
B	4,133,787,696	51.54	25.77	10.64	12.05	1(216)/5(872)/7(1044)
C	819,934,000	45.97	25.28	17.06	11.68	1(41)/1(56)/5(177)
D	915,000,000	53.18	29.25	5.84	11.73	1(19)/4(76)/15(300)

***Source**: Developed by the authors based on the BIM consultancy cost estimations.*

The variation in labour input and personnel composition across cases reflects different estimation approaches, including role-based, discipline-based, and task-based BIM implementation.

5.2 DOMINANCE OF LABOUR INPUTS IN BIM CONSULTANCY COSTS

Labour inputs constitute the largest share of BIM consultancy cost estimates across all cases. As shown in Table 3, labour accounts for approximately 45.97% to 53.69% of total cost estimates, followed by management costs (25.28%–29.53%), while other components contribute smaller proportions. Labour costs are primarily determined by the number of specialists and the duration of their involvement, calculated using standard professional rates. The cross-case comparison shows that labour shares exceed 50% in Cases A and B (53.69% and 51.54%, respectively), while lower proportions are observed in Cases C and D (45.97% and 48.54%). Although technical resources are included, they represent a relatively small share of total costs, with operational costs ranging from 4.38% to 17.06%. Labour allocation patterns varied depending on implementation structure and scope definition. In Case D, labour allocation follows standardised estimation norms, resulting in a more stable distribution across cost components compared to cases with more detailed task-based or EIR-defined scopes. Overall, the results indicate a relatively consistent cost structure across cases in which labour remains the dominant component, complemented by substantial management and indirect costs.

5.3 BIM PERSONNEL STRUCTURES IN CONSULTANCY SERVICES

BIM implementation typically involves three core roles: BIM managers, BIM coordinators and BIM modellers. Across the analysed cases, modelling activities consistently account for the majority of labour input. In Case A, BIM modellers represent 495 of 675 person-days (~73%), compared to 135 for coordinators and 45 for management roles, while a similar pattern is observed in Case D (300 of 395 person-days, ~76%). In contrast, different structuring approaches are observed in Cases B and C. In Case B, BIM labour is embedded within discipline-based teams, making the distribution of roles less explicitly separated but still dominated by modelling-related activities. In Case C, labour is organised through a task-based allocation with a total of 117 person-days, reflecting a more activity-oriented structuring of BIM work. Despite these differences, modelling remains the dominant labour component across all cases. The results indicate three distinct labour structuring logics: role-based (Cases A and D), discipline-based (Case B), and task-based (Case C), which correspond to different ways of organising and estimating BIM consultancy labour inputs. In role-based estimation, labour is defined through explicit BIM roles; in discipline-based estimation, BIM work is embedded within design teams; and in task-based estimation, labour is derived from explicitly defined BIM activities.

5.4 KEY FACTORS INFLUENCING BIM CONSULTANCY COST

The cross-case comparison indicates that BIM cost estimation varies across projects according to several observable factors. First, the stage of implementation is associated with differences in cost magnitude. Case A involves design-stage BIM with extended scope, while Case B spans multiple stages, resulting in higher labour input. Case C reflects a more limited scope with lower total labour requirements. Second, differences in implementation approach are reflected in the structure of cost estimates. Compared to Case A, Case B exhibits a more formalised, EIR-driven structure with clearly defined coordination and information management components. Case C reflects integrated, task-based BIM implementation, while Case D follows a TOR-defined approach in which cost estimation is aligned with standardised norms. Third, variations in project complexity are associated with differences in labour demand. Case B involves multiple technical disciplines and extensive coordination requirements, while Case C has a simpler structure with lower coordination intensity. Finally, the presence of formal information requirements (e.g., EIR) and scope definitions (e.g., TOR) is reflected in the organisation of BIM cost estimates, particularly in relation to coordination activities, data management processes, and labour allocation. Overall, the results show that BIM consultancy cost estimates vary across cases in relation to project stage, implementation approach, project complexity, and the structure of defined BIM requirements.

6. DISCUSSION AND IMPLICATIONS FOR THE OWNERS

6.1 BIM CONSULTANCY COST STRUCTURES IN PRACTICE

The analysed projects indicate that BIM consultancy costs in Vietnamese public construction projects are formalised through consultancy pricing and procurement mechanisms rather than treated as standalone digital technology expenditure. Across all four cases, BIM implementation was incorporated into officially approved consultancy cost estimates, where cost items were organised under standard construction investment cost categories, including expert costs, management costs, operational costs, pre-tax profit and value-added tax (VAT). This structure suggests that BIM implementation is institutionalised as part of consultancy services embedded within public investment planning and approval systems. This finding extends previous BIM cost studies, which have mainly examined BIM benefits, adoption costs, or cost–benefit relationships (Bryde et al., 2013; Gharaibeh et al., 2024; Lu et al., 2014), by showing how BIM consultancy costs are formally translated into approved project cost structures. While prior studies commonly identify labour, software, hardware and training as key BIM cost elements (Borrmann et al., 2018; Hardin & McCool, 2015; Sacks et al., 2018), the present cases further show how these elements are reorganised within public-sector consultancy pricing categories, including expert costs, management costs, operational costs, profit and VAT.

The reviewed estimation documents further show that BIM implementation was operationalised through different scope-definition mechanisms across projects. In Cases A and B, BIM consultancy services were organised through relatively explicit EIR-oriented implementation structures involving BIM execution planning, coordination management and CDE setup activities. For example, the detailed labour schedule in Case A included dedicated work items for BIM execution planning and CDE establishment prior to modelling activities, together with coordination and clash-handling tasks during implementation. Similarly, the cost documentation in Case B was approved as a standalone BIM consultancy package with a total estimated value exceeding VND 4.13 billion, indicating a relatively formalised implementation arrangement within the procurement structure. By contrast, Case C reflected a more integrated implementation mechanism in which BIM-related activities were embedded directly within the design consultancy process. The approved estimation structure combined design consultancy and BIM-related implementation under the same consultancy arrangement, while the detailed estimation tables allocated BIM activities through task-oriented work items associated with design coordination and model-based deliverables. This produced a more explicit operational linkage between BIM tasks and design production activities compared with the standalone consultancy arrangements observed in Cases A and B. Another variation can be observed in Case D, where BIM implementation was still formally defined through a dedicated BIM estimation structure but relied more heavily on predefined regulatory norms and standardised cost calculation logic. The estimation tables explicitly linked management costs to a fixed percentage of expert costs (55% × Ccg), while pre-tax profit and VAT were also calculated through predefined formulas. This suggests a more norm-based institutional logic in which BIM consultancy pricing was stabilised through standardised estimation procedures rather than through highly customised scope definition.

The cases reveal notable differences in the visibility of operational and technical resources within BIM consultancy estimation structures. In Cases A and D, the estimation appendices explicitly identified items such as CDE licensing, Autodesk AEC software, workstation depreciation, internet infrastructure and meeting-related coordination expenses as separate operational cost categories. The presence of these items indicates that BIM cost structures extend beyond modelling outputs and include broader information management and coordination infrastructure required to support BIM-enabled project delivery. Apparently, the analysed cases suggest that BIM consultancy cost structures are shaped by implementation arrangements, procurement mechanisms and institutional estimation procedures established during project planning. Rather than reflecting a uniform technical pricing model, BIM cost estimation appears to operate as a governance-dependent process in which project scope definition, coordination requirements and regulatory estimation logic collectively influence how consultancy costs are organised and formalised.

6.2 LABOUR-INTENSIVE NATURE OF BIM IMPLEMENTATION

Despite differences in implementation arrangement and estimation structure, labour consistently remained the dominant component of BIM consultancy cost estimates across all analysed cases. Table 3 shows that labour accounted for approximately 45.97%–53.69% of total BIM consultancy cost estimates, exceeding all other cost categories. This result is consistent with previous studies suggesting that BIM implementation is labour- and expertise-intensive (Hardin & McCool, 2015; Lu et al., 2014; Sacks et al., 2018), but the present study adds empirical detail by quantifying labour shares and personnel/person-day allocations in approved consultancy cost estimates. However, the detailed estimation appendices suggest that this labour intensity was associated not only with modelling production, but also with coordination, information exchange and management-related activities embedded within BIM workflows.

The labour allocation structure in Case A illustrates this pattern clearly. Although BIM modelers accounted for most total person-days (495 out of 675 person-days), the detailed labour schedule also allocated substantial effort to BIM management and coordination functions, including BIM execution planning, CDE setup, clash coordination, model updating and quantity extraction activities. These activities indicate that BIM implementation required continuous coordination and information management effort extending beyond geometric model production alone. Case B demonstrates an even stronger labour-intensive pattern within an EIR-driven implementation context. The approved estimation structure allocated more than VND 2.06 billion to expert costs alone, while management costs exceeded VND 1.06 billion. This distribution suggests that formalised information exchange and governance requirements substantially increased the organisational and coordination effort associated with BIM implementation. In this respect, the findings reinforce previous studies arguing that BIM adoption depends heavily on interdisciplinary coordination and specialised professional expertise rather than purely technical modelling capability (Hardin & McCool, 2015; Sacks et al., 2018). At the same time, labour intensity varied depending on implementation structure. In Case C, BIM activities were integrated more directly into design consultancy workflows through task-based allocation mechanisms. Although labour remained the largest cost component, operational expenditures became relatively more visible within the estimation structure due to tighter integration between BIM tasks and design production activities. Meanwhile, Case D exhibited a more stabilised labour allocation pattern linked to predefined estimation norms and TOR-defined scope. The detailed expert allocation table in Case D identified 20 BIM personnel distributed across management, coordination and modelling roles, with modelling specialists representing the largest group (15 out of 20 personnel).

Another important observation is that management and indirect costs consistently occupied a substantial proportion of total BIM consultancy estimates across all projects. This indicates that BIM implementation in public projects functions not simply as a technical modelling exercise, but as a coordinated consultancy service requiring supervision, information control, coordination management and administrative support throughout project delivery. Accordingly, labour demand appears to be shaped not only by modelling workload, but also by the organisational complexity associated with managing BIM-enabled workflows in consultancy-driven project environments.

6.3 IMPLICATIONS FOR PROJECT OWNERS AND COST PLANNING

The findings provide several practical implications for project owners. First, BIM budgeting should prioritise labour estimation, particularly team size, role allocation, and working duration. Given that labour accounts for approximately 46–54% of total BIM consultancy cost estimates, small variations in team composition or project duration can significantly affect overall budgets. Second, implementation arrangement has important budgeting implications for project owners. More detailed BIM scope definition may improve cost transparency and project control but can also increase managerial complexity and coordination effort during implementation. Third, project complexity and interdisciplinary coordination requirements directly influence labour demand and overall BIM cost estimates. Projects involving multiple technical disciplines or intensive coordination requirements tend to exhibit higher labour intensity and greater variability in cost distribution. Finally, defining clear information requirements (EIR) and scope specifications (TOR) is critical for improving cost transparency and estimation reliability. The cross-case analysis suggests that more detailed information requirements can improve cost clarity and project control but may also increase labour demand, while more standardised approaches can simplify budgeting at the expense of analytical precision. More broadly, project owners face a trade-off between standardised estimation approaches and more detailed, task-based approaches, with implications for both cost accuracy and management complexity. These findings indicate that effective BIM cost planning requires aligning estimation approaches with project-specific implementation logic rather than relying solely on standardised cost norms.

7. CONCLUSIONS

This study provides empirical insights into the structure and estimation of BIM consultancy cost estimates in public construction projects based on document analysis of approved cost estimation reports. The findings confirm that BIM cost estimates in the analysed context follow consultancy-based pricing structures and vary systematically depending on implementation approach. These differences reflect distinct BIM implementation mechanisms identified across the analysed cases. For project owners, the findings highlight the importance of clearly defining BIM scope, team composition and information requirements during project planning. More broadly, project owners face a trade-off between standardised estimation approaches, which simplify budgeting, and more detailed task-based approaches, which improve cost transparency but increase complexity.

The main contribution of this study is to demonstrate that BIM consultancy cost estimates are formed through identifiable implementation mechanisms rather than through purely technical resource calculations. Across the analysed cases, BIM cost structures were shaped by different implementation logics, including EIR-driven consultancy, integrated design–BIM delivery, and TOR-based estimation approaches embedded within institutional cost management frameworks. Although the findings are derived from Vietnamese public construction projects, the observed patterns may also be relevant to other consultancy-driven BIM environments operating under comparable regulatory and procurement conditions. However, because the analysis is based on four approved public project cases and focuses on planned cost estimation documents rather than realised expenditures, the findings should be interpreted as indicative evidence of BIM cost estimation practices rather than generalisable evidence of actual implementation costs. In this respect, the study primarily reflects how BIM costs are structured and institutionalised within project planning and procurement systems. Future research may extend this work by examining larger datasets, comparing BIM cost estimation practices across different regulatory environments, and investigating the relationship between estimated BIM consultancy costs and actual project performance outcomes.

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9. REFERENCES

Azhar, S. (2011). Building information modeling (BIM): Trends, benefits, risks, and challenges for the AEC industry. *Leadership and Management in Engineering*, *11*(3), 241-252. https://doi.org/10.1061/(ASCE)LM.1943-5630.0000127

Barnes, P., & Davies, N. (2014). *BIM in Principle and in Practice*. ICE publishing London.

Borrmann, A., Konig, M., Koch, C., & Beetz, J. (2018). *Building Information Modeling–Technology Foundations and Industry Practice*. Springer International Publishing. https://doi.org/10.1007/978-3-319-92862-3

Bowen, G. A. (2009). Document analysis as a qualitative research method. *Qualitative Research Journal*, *9*(2), 27-40. https://doi.org/10.3316/QRJ0902027

Bryde, D., Broquetas, M., & Volm, J. M. (2013). The project benefits of building information modelling (BIM). *International Journal of Project Management*, *31*(7), 971-980. https://doi.org/10.1016/j.ijproman.2012.12.001

Dao, Q. V., & Nguyen, T.-Q. (2021). A case study of BIM application in a public construction project management unit in Vietnam: Lessons learned and organizational changes. *Engineering Journal*, *25*(7), 177-192. https://doi.org/10.4186/ej.2021.25.7.177

European Commission. (2021). *Calculating costs and benefits for the use of Building Information Modelling in public tenders: Methodology handbook*.

Gharaibeh, L., Eriksson, K., & Lantz, B. (2024). Quantifying BIM investment value: A systematic review. *Journal of Engineering, Design and Technology*, 23 (5), 1384–1403. https://doi.org/10.1108/JEDT-06-2023-0259

Government of Vietnam. (2021). *Decree No. 10/2021/ND-CP on construction investment cost management*. Hanoi, Vietnam. https://vanban.chinhphu.vn/?pageid=27160&docid=202663

Government of Vietnam. (2024). *Decree No. 175/2024/ND-CP on Detailed Provisions and Measures for the Implementation of the Law on Construction Regarding the Management of Construction Activities*. Hanoi, Vietnam. https://vanban.chinhphu.vn/?pageid=27160&docid=212166

Hardin, B., & McCool, D. (2015). *BIM and construction management: proven tools, methods, and workflows*. John Wiley & Sons.

Kumar, B. (2015). *A practical guide to adopting BIM in construction projects*. Whittles Publishing.

Lu, W., Fung, A., Peng, Y., Liang, C., & Rowlinson, S. (2014). Cost-benefit analysis of building information modeling implementation in building projects through demystification of time-effort distribution curves. *Building and Environment*, *82*, 317-327. https://doi.org/10.1016/j.buildenv.2014.08.030

Mai, B. N., Tran, Q. P., & Nguyen, M. D. (2025). Experimental application of BIM in the appraisal of design cost estimates for publicly funded civil building projects. *Journal of Materials and Construction, Ministry of Construction*, *15*(1), 102-111. https://doi.org/10.54772/jomc.01.2025.834

Ministry of Construction. (2021). *Circular No. 11/2021/TT-BXD Guidelines on Certain Aspects of Construction Investment Cost Determination and Management*. Hanoi, Vietnam. https://congbao.chinhphu.vn/van-ban/thong-tu-so-11-2021-tt-bxd-34379.htm

Ministry of Construction. (2024). *Circular No. 09/2024/TT-BXD amending and supplementing several construction cost norms*. Hanoi, Vietnam. https://chinhphu.vn/?pageid=27160&docid=211221

Mitchell, A., Williges, C., Henly-Thomas, S., & Messner, J. (2023). *Lifecycle BIM for Infrastructure: A Business Case for Project Delivery and Asset Management*. National Academies of Sciences, Engineering, and Medicine.

Ngo, T. T., Truyen, D. M., & Tin, H. X. (2020). BIM application for bridge, highway and infrastructure projects in Vietnam. *Transport and Communications Science Journal*, *71*(7), 760-774.

Nguyen, M., Nguyen, T.-Q., Nguyen, Q.T., Vu, N.N., & Thieu, T.T.T. (2021). BIM adoption as a perceived source of competitive advantages and competitive strategies for construction consultancy SMEs: evidence from Vietnam. *AIP Conference Proceedings*, Volume 2428, Issue 1, 060005. AIP Publishing https://doi.org/10.1063/5.0070739

Nguyen, T.-Q., Thieu, T.T.T., & Vu, N.N. (2021). BIM-based competitive advantages and competitive strategies for construction consultancy SMEs: A case study in Vietnam. *International Journal of*

Sustainable Construction Engineering and Technology, *12*(3), 1-11. https://doi.org/10.30880/ijscet.2021.12.03.001

Nguyen, T. H. (2024). Determining the cost of BIM implementation in construction investment projects. *Science and Technology, University of Communication and Transport*, *740*, 180-183.

Pham, V. D., Ta, V. P., Nguyen, M. N., Nguyen, V. V., & Mai, V. (2024). The important roles of BIM in the construction industry in Vietnam: A multi-approach analysis. *International Journal of Sustainable Construction Engineering and Technology*, *15*(4), 176-187. https://doi.org/10.30880/ijscet.2024.15.04.013

Sacks, R., Eastman, C., Lee, G., & Teicholz, P. (2018). *BIM handbook: A guide to building information modeling for owners, designers, engineers, contractors, and facility managers*. John Wiley & Sons.

Yin, K. R. (2018). *Case study research and applications design and methods* (6th ed.). Sage Publications, Inc.