CONSTRUCTION

Impact of Building Information Modelling on Construction Project Management: Evidence from a Mixed-Methods Survey of Professionals in Lagos State, Nigeria

Olusegun O. Olatunji, Akinwale O. Coker

Construction Project Management (CPM), Department of Civil Engineering, University of Ibadan, Ibadan, Oyo State, Nigeria

Published November 2026

Abstract

Building Information Modelling (BIM) is widely promoted as a means of improving construction project management, yet little is known about how professionals in Lagos State, Nigeria, assess its effect across several management dimensions at once. This study examined professionals' assessments of the influence of BIM on project delivery time, cost management, quality management, and stakeholder communication and collaboration, and of the challenges constraining BIM adoption and utilisation. A mixed-methods design combined a structured five-point Likert questionnaire with 20 semi-structured interviews. All 176 BIM-experienced professionals in the purposively identified accessible population were targeted, and 160 valid questionnaires (90.9%) were analysed using descriptive statistics, Relative Importance Index (RII) and one-sample t-tests against the neutral midpoint; interviews were analysed thematically. Respondents rated BIM significantly above neutral on quality management ($M = 4.144$), communication and collaboration ($M = 4.118$), delivery time ($M = 4.077$) and cost management ($M = 3.990$), all $p < .001$. Within every dimension, planning- and design-stage benefits, such as early detection of design errors, activity sequencing and quantity take-off, were rated higher than final-outcome benefits, such as quality of completed work, reduction of completion delays and overall financial performance. Interviewees explained that BIM strengthens visibility and control but cannot offset funding, approval, market and supervision constraints. Shortage of skilled professionals ($RII = 0.816$) and the cost of software and hardware ($RII = 0.811$) were the leading barriers. The findings indicate that BIM's perceived value in Lagos lies chiefly in preventive information management, and that realising it depends on competence, investment and institutional support. The perception-based, cross-sectional design limits causal inference.

Keywords: Building Information Modelling; construction project management; project performance; BIM adoption; mixed methods; Lagos State

1 Introduction

1.1 Background and research problem

Construction project delivery depends on the coordinated work of clients, designers, quantity surveyors, contractors and specialist subcontractors, each of whom generates and interprets project information. When that information is held in separate documents and exchanged sequentially, the result is familiar: design inconsistencies, late discovery of conflicts, rework, cost variation and delay (Parsamehr et al., 2023; Ye et al., 2024). Building Information Modelling (BIM) has been advanced as a response because it links geometric models to non-geometric data such as quantities, programmes

and costs, and therefore supports decisions across the project life cycle rather than only the production of drawings (Olawumi & Chan, 2019; Raza et al., 2023; Wang & Chen, 2023).

International studies associate BIM with better schedule planning and schedule-risk identification (Alnaser et al., 2023; Thaheem et al., 2020), more reliable quantity and cost information (Farouk & Rahman, 2023; Nsimbe & Di, 2024), earlier detection of design conflicts (Cao et al., 2015; Datta et al., 2023) and improved collaboration (Ali et al., 2022; Liu et al., 2017). The same literature, however, indicates that these benefits are conditional on implementation maturity, user competence, organisational readiness and the institutional setting (Al-Ashmori et al., 2022; Chan et al., 2019; Waqar et al., 2023). The distinction between adopting BIM (acquiring tools and producing models) and utilising it (applying it in scheduling, costing, coordination and decision making) is therefore central to any assessment of its effect on project management.

In Nigeria, BIM uptake is acknowledged to be uneven. Existing studies have examined the drivers of implementation (Olanrewaju et al., 2021), barriers to integrating BIM with facility management (Okwe et al., 2023), BIM usage among professionals in Lagos State (Ibrahim et al., 2025), BIM integration in project management in Lagos and Ogun States (Adesina & Adegbile, 2025) and stakeholder-induced scope changes (Adeodu et al., 2026). These contributions establish awareness and usage patterns and address individual issues in depth. To the authors' knowledge, however, fewer studies assess within a single Lagos-based dataset how BIM-experienced professionals rate its influence on delivery time, cost, quality and collaboration together, while also examining the barriers that constrain its use. This study addresses that gap. Its contribution is an integrated, perception-based account of BIM in project management practice in Lagos, with interview evidence used to explain where the perceived benefits are strongest and why they are qualified.

1.2 Aim, objectives and hypotheses

The aim was to examine professionals' assessments of the impact of BIM on construction project management in Lagos State. Five objectives guided the study: to examine the influence of BIM on (1) project delivery time, (2) cost management, (3) quality management and error reduction, and (4) communication, information sharing, coordination and collaborative decision making, and (5) to identify the technological, organisational, professional and institutional challenges affecting BIM adoption and utilisation. Five null hypotheses (H01–H05), one per objective, were tested at the 0.05 level; each states that the relevant construct has no significant influence, as defined by the mean rating not differing from the neutral scale midpoint.

2 Literature review and theoretical framework

2.1 BIM as an information-management platform

Treating BIM as three-dimensional visualisation understates its management relevance. Reviews of the field position BIM as an information-management approach that spans project management knowledge areas, including scope, time, cost, quality, communication and risk (Raza et al., 2023; Wang & Chen, 2023; Ye et al., 2024). The practical consequence is that value depends less on the model itself than on the quality, accessibility and coordination of the information attached to it (Olawumi & Chan, 2019). This is why dimensional applications matter: 4D BIM links the model to the programme, and 5D BIM links it to quantities and cost (Farouk & Rahman, 2023). It also explains the

emphasis on roles such as the BIM manager, whose coordination work determines whether multidisciplinary models are integrated or merely coexist (Sampaio et al., 2023).

2.2 BIM and the four management dimensions

Time. Evidence from Saudi Arabia, using system dynamics, indicates that BIM can help reduce construction delays (Alnaser et al., 2023), and schedule-risk research links specific BIM functions to identified delay risks (Thaheem et al., 2020). Studies in residential settings report time savings (Almujibah, 2023). A reasonable caution, consistent with the socio-technical perspective adopted below, is that 4D models help only when programmes and models are kept current, which makes schedule benefits dependent on practice and not on software alone.

Cost. Model-based quantity extraction and cost integration are the most frequently cited cost mechanisms (Farouk & Rahman, 2023; Nsimbe & Di, 2024). Case evidence from a Kenyan port development project and from a residential case in Bangladesh supports improved estimating and quantity accuracy (Datta et al., 2023; Nsimbe & Di, 2024). Because such evidence is largely case-based, its transferability to other contexts is uncertain.

Quality. Early clash detection and coordinated review are the principal quality mechanisms (Cao et al., 2015; Parsamehr et al., 2023), with associated reductions in design error and rework (Akter et al., 2024; Datta et al., 2023). Much of this evidence concerns design-stage coordination, not measured site quality.

Communication and collaboration. A shared model gives participants a common reference and can alter communication patterns (Huang et al., 2022; Liu et al., 2017). Collaboration nevertheless depends on trust, contractual clarity and willingness to share information (Ali et al., 2022), and so cannot be assumed to follow from the technology.

Context also conditions the evidence. A review of UK residential projects reports both benefits and adoption challenges (Georgiadou, 2019); an evaluation of mass house building projects examines BIM's effect in one specific project type (Sarvari et al., 2020); and research in Indonesia identifies the factors on which BIM's contribution to the project management life cycle depends (Latupeirissa & Arrang, 2024). These studies differ in setting and method, but they converge on the point that BIM's effect is mediated by implementation conditions and not delivered by the technology alone.

Across these strands, the literature tends to demonstrate benefits in the mechanisms through which BIM operates (sequencing, take-off, clash detection, shared models) more convincingly than in final project outcomes, which are exposed to many non-BIM influences. This observation informs the interpretation of the results below.

2.3 Adoption and utilisation in Nigeria

Nigerian and comparable evidence identifies the same cluster of constraints: scarce BIM skills, high software and hardware costs, limited management support, weak infrastructure, resistance to changing practice, interoperability problems and inadequate standards or policy (Chan et al., 2019; Mohammed & Hilal, 2024; Okwe et al., 2023; Olanrewaju et al., 2021). Recent Lagos-based work documents growing awareness and use, while indicating that depth of utilisation varies by organisation and project (Adesina & Adegbile, 2025; Ibrahim et al., 2025).

2.4 Theoretical framework

Three perspectives are combined. The Technology–Organisation–Environment (TOE) framework explains adoption conditions through technological, organisational and external contexts (Tornatzky & Fleischer, 1990). Diffusion of Innovation theory explains why adoption and utilisation vary across firms through perceived relative advantage, compatibility, complexity, trialability and observability (Rogers, 2003). Socio-Technical Systems theory argues that performance emerges from the interaction of technical and social subsystems, and therefore cautions against technological determinism (Trist & Bamforth, 1951). Together they support the study's premise that BIM's effect on project management depends on utilisation within organisational and institutional conditions. Figure 1 presents the resulting framework: BIM adoption and utilisation is related to four perceived outcomes, and four categories of challenge condition that relationship. The conditioning role of the challenges is conceptual and was not tested statistically.

2.5 Research gap

Three limitations of the existing evidence motivate the study. First, BIM's effects on time, cost, quality and collaboration are commonly examined in separate studies, so the relative strength of the perceived benefits across dimensions is seldom visible. Second, Nigerian studies have concentrated on awareness, drivers, barriers and single applications (Ibrahim et al., 2025; Okwe et al., 2023; Olanrewaju et al., 2021), leaving the assessment of project management outcomes comparatively thin. Third, barriers are seldom examined alongside performance assessments in the same dataset, so the conditions limiting realised benefit remain separate from the benefits themselves. The study responds by collecting professionals' ratings of all four performance dimensions and the main challenges from one population, and by using interviews to explain the pattern. These statements describe the literature reviewed here and should be re-checked against the latest Lagos-based publications before submission.

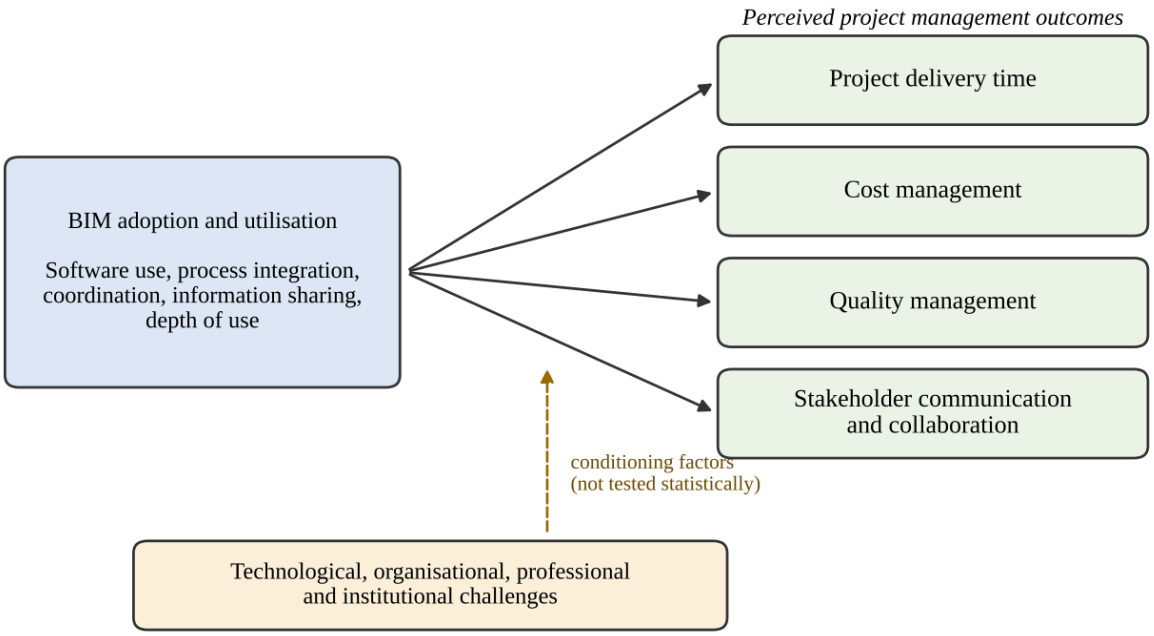


Figure 1. Conceptual framework of the study.

3 Research methodology

3.1 Research design

The study used a mixed-methods design in which a structured questionnaire survey provided standardised, quantifiable assessments and semi-structured interviews provided explanatory evidence on how and why BIM influenced practice. The two strands were compared during interpretation to triangulate findings. Where access was granted, project documents (models, clash reports, programmes and cost estimates) were consulted to support the interpretation of both strands; they were not analysed as a separate data source. The design is cross-sectional, and the study is best characterised as a survey of BIM-experienced professionals in Lagos State, supplemented by interviews, and not as a single-case study.

3.2 Population and sampling

The study covered building projects in Lagos State (residential, commercial, public/institutional and mixed-use). Firms, consultancy practices and projects with BIM experience were identified purposively. The accessible population comprised 176 professionals with verifiable involvement in BIM-enabled projects within these firms and projects, spanning project managers, architects, engineers, quantity surveyors, BIM coordinators/managers, contractors, consultants and client representatives. Because this population could be identified and reached, all 176 were targeted (a census) and no sampling formula was applied. Respondents were screened for hands-on BIM involvement before questionnaires were issued. The interview sample comprised 20 purposively selected professionals with substantial BIM and project management experience (5–12 years of BIM experience; seven of the eight professional groups represented).

3.3 Instruments

The questionnaire had seven sections. Section A recorded respondent characteristics; Section B addressed BIM adoption and use (eight items); and Sections C to G contained five Likert items each on delivery time, cost management, quality management, communication and collaboration, and implementation challenges (25 items in total), rated from 1 (strongly disagree) to 5 (strongly agree). Items were developed from the literature (Table 2 in the Results lists them). A semi-structured interview guide covered implementation experience, scheduling, cost, quality, information sharing, stakeholder management, barriers and improvement strategies.

3.4 Validity and reliability procedures

Face and content validity were established through review by five experts (two construction project management specialists, two academics with BIM research experience and one research-methods specialist), with item-level and scale-level content validity indices computed. Construct validity was examined using the Kaiser–Meyer–Olkin measure (threshold ≥ 0.60), Bartlett's test of sphericity and factor loadings. The questionnaire was piloted with 40 BIM-experienced professionals in Ogun State, who were excluded from the main sample, and internal consistency was assessed using Cronbach's alpha with a threshold of 0.70.

3.5 Data collection and analysis

Questionnaires were distributed in hard copy and electronically, with reminders; 160 of 176 were returned in usable form (90.9%), and questionnaires with substantial missing or contradictory

responses were excluded. All 160 valid cases completed all 25 Likert items, so the same n applies to every analysis. Interviews were recorded with consent (or documented in detailed notes where recording was declined), transcribed, coded and grouped into themes aligned with the objectives. Quantitative analysis used frequencies, percentages, means and standard deviations. For the challenges, the Relative Importance Index (RII) was computed as the item mean divided by 5. Each null hypothesis was tested with a one-sample t-test comparing the construct mean with the neutral midpoint of 3.00 ($\alpha = 0.05$). This tests whether respondents' assessments differ from neutrality; it does not estimate the effect of BIM on measured project performance.

Integration of the two strands occurred at the interpretation stage. Survey results were first summarised by construct and item rank; interview themes were then compared with the ranking to establish whether they corroborated, qualified or contradicted it. No interview contradicted a survey result, and the interviews were used mainly to explain why particular items ranked lower.

3.6 Ethical considerations

Participation was voluntary and informed consent was obtained. Respondents were not required to disclose commercially sensitive information, and anonymity was maintained through coded identifiers (INT01–INT20) and aggregated reporting. Project documents were accessed with organisational permission.

4 Results

4.1 Respondent profile

Table 1 summarises the 160 valid respondents. Engineers (21.3%), architects (15.6%) and quantity surveyors (14.4%) were the largest groups, and all eight professional categories were represented. The sample was predominantly male (71.3%; female 27.5%; 1.3% undisclosed) and well qualified (B.Sc./B.Tech. 45.0%, M.Sc./M.Tech. 36.3%, PhD 5.0%). In total, 60.6% had more than ten years of construction experience, and 85.0% had at least two years of BIM experience, which supports the credibility of the assessments reported below.

Table 1. Characteristics of valid respondents (N = 160).

Variable	Category	n	%
Professional role	Engineer	34	21.3
	Architect	25	15.6
	Quantity surveyor	23	14.4
	Project manager	22	13.8
	BIM coordinator/manager	19	11.9
	Contractor	18	11.3
	Consultant	12	7.5
	Client representative	7	4.4
BIM experience	Less than 2 years	24	15.0
	2–5 years	63	39.4
	6–10 years	51	31.9

Variable	Category	n	%
	More than 10 years	22	13.8
Organisation type	Construction firm	49	30.6
	Consultancy firm	43	26.9
	Property development firm	21	13.1
	Client organisation	21	13.1
	Government agency	17	10.6
	Other	9	5.6

Note: Percentages are of 160 valid responses. Source: field survey, 2026.

4.2 Delivery time, cost, quality and collaboration

Table 2 reports the item-level assessments, and Table 3 summarises the construct-level tests. Every performance item mean exceeded 3.88, and all construct means exceeded the neutral midpoint (all $p < .001$).

Delivery time. The construct mean was 4.077 (SD = 0.560). Sequencing of construction activities ranked first (M = 4.119; 83.8% agreement) followed by scheduling accuracy (M = 4.112; 81.9%) and early identification of possible delays (M = 4.081). Reduction of delays in project completion ranked lowest (M = 4.025), although 78.1% still agreed.

Cost management. The construct mean was 3.990 (SD = 0.588), the lowest of the four performance constructs. Quantity take-off accuracy and efficiency ranked first (M = 4.100; 83.8% agreement), then estimate accuracy (M = 4.056) and rapid identification of the cost effects of design change (M = 3.987). Cost monitoring and control (M = 3.925) and overall financial performance (M = 3.881) were rated lowest.

Quality management. This construct recorded the highest mean (M = 4.144; SD = 0.562). Early identification of design errors ranked first (M = 4.244; 86.3% agreement), followed by clash detection (M = 4.200; 87.5%), coordination among architectural, structural and services designs (M = 4.150), reduction of site mistakes and rework (M = 4.094) and overall quality of completed work (M = 4.031).

Communication and collaboration. The construct mean was 4.118 (SD = 0.570). Coordination among professionals (M = 4.150; 85.0% agreement) and information sharing (M = 4.144; 85.0%) ranked highest, followed by communication (M = 4.119). Informed decision making and inter-organisational collaboration shared the lowest mean (M = 4.088).

Table 2. Respondents' assessment of BIM on performance items (n = 160).

Item	M	SD	% agree
Delivery time			
BIM improves sequencing of construction activities	4.119	0.693	83.8
BIM makes project scheduling more accurate	4.112	0.733	81.9
BIM helps identify possible delays before they occur	4.081	0.724	81.3
BIM makes progress monitoring against the planned schedule easier	4.050	0.696	81.9
BIM helps reduce delays in project completion	4.025	0.715	78.1

Item	M	SD	% agree
Cost management			
BIM makes quantity take-off more accurate and efficient	4.100	0.718	83.8
BIM improves construction cost estimate accuracy	4.056	0.735	80.6
BIM helps identify the cost effects of design changes quickly	3.987	0.733	77.5
BIM improves monitoring and control of project costs	3.925	0.738	76.9
BIM contributes to better overall financial performance	3.881	0.728	73.8
Quality management			
BIM helps identify design errors before construction begins	4.244	0.714	86.3
BIM clash detection helps prevent conflicts between building components	4.200	0.678	87.5
BIM improves coordination among architectural, structural and services designs	4.150	0.700	85.6
BIM helps reduce construction mistakes and rework on site	4.094	0.723	81.9
BIM contributes to better overall quality of completed construction work	4.031	0.711	80.0
Communication and collaboration			
BIM makes coordination among different professionals easier	4.150	0.691	85.0
BIM improves sharing of project information among stakeholders	4.144	0.669	85.0
BIM improves communication among project participants	4.119	0.702	83.1
BIM supports faster and better informed decision making	4.088	0.674	83.8
BIM improves collaboration among organisations involved in projects	4.088	0.711	81.3

Note: M = mean on a five-point scale (5 = strongly agree); SD = standard deviation; % agree = strongly agree plus agree. Source: field survey, 2026.

Table 3. One-sample t-tests of construct means against the neutral midpoint (3.00).

Hypothesis (construct)	M	SD	t(159)	p	Decision
H01 Delivery time	4.077	0.560	24.327	< .001	Reject
H02 Cost management	3.990	0.588	21.297	< .001	Reject
H03 Quality management	4.144	0.562	25.748	< .001	Reject
H04 Communication and collaboration	4.118	0.570	24.810	< .001	Reject
H05 Challenges	3.932	0.546	21.615	< .001	Reject

Note: Two-tailed tests at $\alpha = 0.05$; SD is the standard deviation of respondent-level construct scores. Source: field survey, 2026.

4.3 Challenges affecting adoption and utilisation

All five challenges were rated above neutral (grand mean = 3.932; overall RII = 0.786; Table 4). Shortage of trained BIM professionals ranked first (M = 4.081; RII = 0.816; 83.8% agreement), followed by the cost of software and hardware (M = 4.056; RII = 0.811; 83.8%). Inadequate standards, policy and institutional support (RII = 0.786), inadequate internet and digital infrastructure (RII = 0.771) and resistance to changing traditional practice (RII = 0.747; 69.4% agreement) followed.

Table 4. Challenges affecting BIM adoption and utilisation.

Rank	Challenge	M	RII	% agree
1	Shortage of trained and experienced BIM professionals	4.081	0.816	83.8
2	High cost of BIM software and computer hardware	4.056	0.811	83.8
3	Inadequate BIM standards, policies and institutional support	3.931	0.786	77.5
4	Inadequate internet and digital infrastructure	3.856	0.771	75.6
5	Resistance to changing traditional construction practices	3.737	0.747	69.4
	Overall	3.932	0.786	

Note: RII = Relative Importance Index (mean/5). % agree computed from the reported response frequencies (n = 160). Source: field survey, 2026.

4.4 Hypothesis tests

All five null hypotheses were rejected (Table 3). The tests indicate that respondents' mean assessments were significantly more favourable than neutral for each performance construct, and that the challenges were significantly acknowledged as constraints. They do not constitute evidence of causal effects on measured project outcomes.

4.5 Interview findings

Table 5 presents the profile of interview participants (n = 20).

Table 5. Profile of interview participants (n = 20).

Code	Professional role	BIM experience (years)	Organisation type
INT01	Project manager	9	Construction firm
INT02	Architect	7	Consultancy firm
INT03	Quantity surveyor	8	Consultancy firm
INT04	Civil engineer	6	Construction firm
INT05	BIM coordinator	10	Consultancy firm
INT06	Contractor	5	Construction firm
INT07	Project manager	12	Property development firm
INT08	Architect	6	Consultancy firm
INT09	Quantity surveyor	7	Construction firm
INT10	Structural engineer	9	Consultancy firm
INT11	BIM manager	11	Construction firm
INT12	Client representative	5	Client organisation
INT13	Project manager	8	Government agency
INT14	Services engineer	6	Consultancy firm
INT15	Contractor	7	Construction firm
INT16	Architect	10	Property development firm
INT17	Quantity surveyor	9	Consultancy firm

Code	Professional role	BIM experience (years)	Organisation type
INT18	BIM coordinator	8	Construction firm
INT19	Engineer	7	Government agency
INT20	Project manager	11	Client organisation

Note: Source: field survey, 2026.

Table 5 profiles the 20 interviewees: four project managers, three architects, three quantity surveyors, four engineers, three BIM coordinators/managers, two contractors and one client representative, with 5–12 years of BIM experience, drawn from construction, consultancy, property development, client and government organisations. Their accounts corroborated the survey and qualified it in a consistent way. On time, a project manager (INT07) described discovering sequencing conflicts "much earlier" through coordination meetings, while another (INT01) stressed that the advantage is "better control rather than a promise that nothing will delay the project", since funding, approvals, materials and client changes also drive delay. On cost, a quantity surveyor (INT03) emphasised linking quantities directly to the model so that design changes can be reviewed without remeasuring from the start, while INT17 saw BIM "mainly as improving cost control and cost visibility", because prices, exchange rates and late changes remain outside its reach. On quality, a BIM coordinator (INT05) described clashes between ducts, beams and pipework becoming evident only when discipline models are combined, whereas a structural engineer (INT10) described BIM as supporting rather than replacing normal quality control, as workmanship and supervision still determine finished quality. On collaboration, a BIM manager (INT11) noted that coordination meetings are more productive around a shared model, but a client representative (INT12) observed that collaboration "remains partly a management and relationship issue" because consultants differ in their willingness to share information. On barriers, a BIM coordinator (INT18) argued that awareness is no longer the main problem; the scarcer capability is managing coordinated models and linking BIM to scheduling and costing, and a contractor (INT06) noted that costs extend beyond licences to hardware, training and workflow change.

5 Discussion

5.1 A mechanism-to-outcome gradient

The most informative pattern in the data is consistent across all four performance constructs: items describing planning- or design-stage mechanisms were rated higher than items describing final project outcomes (Figure 2). Sequencing outranked reduction of completion delays; quantity take-off outranked overall financial performance; early identification of design errors outranked the quality of completed work; and coordination outranked inter-organisational collaboration. The gaps vary in size and, with these data, are best read as a descriptive pattern in the item rankings and not as a tested effect. The interviews offer a coherent explanation: BIM improves what project teams can see, check and anticipate, but final time, cost and quality outcomes also depend on funding, procurement, market conditions, supervision and inter-organisational behaviour that the model does not control. This reading is consistent with Socio-Technical Systems theory, under which information improvements translate into performance only when social and organisational conditions allow.

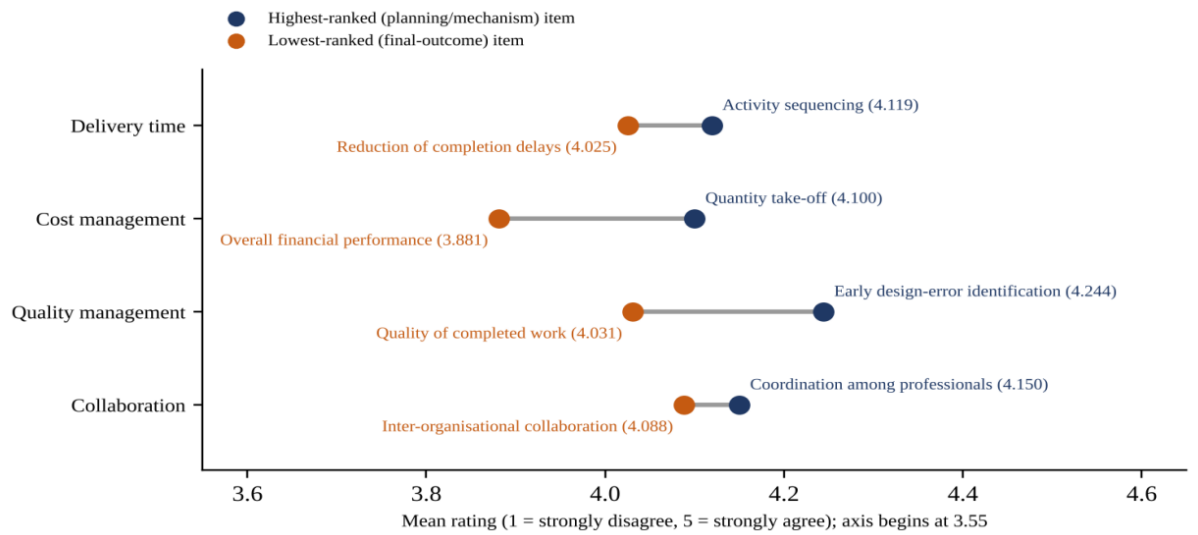


Figure 2. Highest- and lowest-ranked item means within each performance construct (n = 160).

5.2 Relation to existing literature

The favourable assessments of scheduling and sequencing agree with schedule-focused studies (Al-naser et al., 2023; Thaheem et al., 2020), and the emphasis on quantity take-off and estimating agrees with cost-focused work (Farouk & Rahman, 2023; Nsimbe & Di, 2024). The strong rating of early error detection and clash detection corresponds with studies identifying coordination as the main quality mechanism (Cao et al., 2015; Datta et al., 2023). The interview evidence on collaboration echoes research showing that BIM can change communication patterns but does not remove organisational barriers (Huang et al., 2022; Liu et al., 2017) and that collaboration carries risks linked to trust and responsibility (Ali et al., 2022). The overall pattern of favourable but qualified assessments is also compatible with work in which BIM implementation explains a substantial, but not complete, share of overall project success (Waqar et al., 2023) and in which project control mediates the relationship (Waqar & Mansoor, 2024). Because those studies use different samples, contexts and constructs, the comparison is indicative and not a replication.

5.3 Challenges in a Lagos context

The prominence of skills shortage and cost agrees with Nigerian and international findings (Chan et al., 2019; Okwe et al., 2023; Olanrewaju et al., 2021). The interviews sharpen the point: respondents distinguished awareness and basic modelling from the advanced capability needed for coordinated models and BIM-linked scheduling and costing. Through the lens of Diffusion of Innovation theory, this suggests that complexity and compatibility, and not awareness, may be the binding constraints on deeper utilisation, while the TOE framework locates the cost and institutional barriers in the organisational and environmental contexts. Resistance to change ranked lowest yet was still endorsed by 69.4% of respondents and should not be dismissed.

5.4 Interpreting perception evidence

Three cautions apply to the gradient and to the ratings generally. First, the differences between highest- and lowest-ranked items are modest relative to the item standard deviations (about 0.7), and no formal test of the differences was conducted; the pattern is notable chiefly because its direction is the same in all four constructs. Second, every item mean lies in the agreement range, which is compatible with genuine perceived value but also with the selection and acquiescence effects noted

in the limitations, since all respondents had BIM experience and all outcome items were positively worded. Third, perceived improvement is not measured improvement: respondents may credit BIM for outcomes that other practices produced. The interviews mitigate, but cannot remove, these concerns, because interviewees were also BIM-experienced. The findings are therefore best treated as informed professional judgement about where BIM adds value, and as hypotheses for testing with objective project data.

6 Theoretical and practical implications

Theoretically, the study supports treating BIM as a socio-technical innovation whose perceived value is concentrated in preventive information management. It also supports distinguishing adoption from utilisation when evaluating benefits, and it suggests that studies of BIM and project performance should separate mechanism-level from outcome-level measures, because the two behave differently. The combined use of TOE, Diffusion of Innovation and Socio-Technical Systems theories proved useful for interpreting adoption conditions, variation in utilisation and the limits of technological determinism, although these theories were used interpretively and were not tested.

For project managers and contractors, the results point to embedding 4D scheduling in routine programme reviews and recognising that BIM strengthens control and early warning rather than guaranteeing on-time completion. Quantity surveyors and cost consultants should validate model-based quantities before using them in financial decisions. Design teams should make multidisciplinary clash review a standard pre-construction quality practice. Clients and lead consultants should define responsibilities for creating, updating and approving model information, since collaboration depends on clear responsibilities. For policymakers, professional bodies and universities, the ranking of skills shortage, cost and weak standards points to advanced, utilisation-oriented training, phased investment support and clearer BIM standards and procurement requirements.

The study also offers a transferable analytical lens. Reporting item-level rankings within constructs, alongside construct means, exposes differences in perceived value that construct means conceal, and pairing them with interviews explains the reasons for those differences. Researchers in other developing construction economies could apply the same design to test whether the mechanism-to-outcome gradient recurs, which would show whether it reflects BIM itself or the Lagos context.

7 Limitations and future research

Several limitations qualify the findings. First, the evidence is perception-based and self-reported; no objective measures of schedule variance, cost variance or defect rates were analysed. Second, all respondents had BIM experience and all outcome items were positively worded, so selection, acquiescence and ceiling effects may have raised ratings. Third, one-sample t-tests against the midpoint establish that assessments differ from neutrality, but they cannot show causal impact, and they do not test the relationship between BIM utilisation and outcomes or the conditioning role of the challenges. Fourth, the design is cross-sectional and confined to Lagos State and mainly to buildings, so generalisation to other states or to infrastructure projects should be cautious. Fifth, the census covered 176 professionals in purposively selected firms and projects, so the results describe this population and not Nigerian construction professionals generally. Future studies could use larger multi-state samples, structural equation modelling or regression to test relationships and moderation, and compare BIM and non-BIM projects using objective performance data. Longitudinal

designs could examine whether increasing BIM maturity produces sustained improvement, and a validated Nigerian BIM maturity framework could be developed.

8 Conclusion and recommendations

BIM-experienced professionals in Lagos State rated BIM significantly above neutral on delivery time, cost management, quality management and stakeholder communication and collaboration, with quality management rated highest. Ratings were highest for planning- and design-stage mechanisms and lower for final outcomes, and interviewees explained that BIM strengthens visibility and control without removing external constraints. Skills shortage and cost were the leading barriers. The evidence supports the conclusion that, in this setting, BIM is perceived mainly as a preventive information-management tool whose value depends on competence, investment and institutional support. Because the evidence is perception-based and cross-sectional, claims about causal or measured performance effects remain to be tested.

Recommendations follow from the findings. Firms should integrate BIM into scheduling and cost routines instead of limiting it to visualisation, and should validate model-based quantities before financial use. Coordinated multidisciplinary model review should become standard on complex projects, supported by agreed information-management responsibilities. Government, professional bodies, universities and firms should jointly prioritise advanced BIM training, standards and procurement requirements, and phased investment in hardware and software.

References

[1] Adeodu AO, Itanola TA, Daniyan IA (2026). Impact of building information modelling (BIM) on stakeholder-induced scope changes in construction projects in urban area of Lagos State. *LASU Journal of Multidisciplinary Nigerian Studies*, 2, 199–209.

[2] Adesina AJ, Adegbile M (2025). Building information modelling (BIM) integration for construction project management in Lagos and Ogun States, Nigeria. *FUTA Architecture, Construction, Urbanism Journal*, 1(1), 48–62.

[3] Akter J, Datta SD, Islam M, Tayeh B, Sraboni SA, Das N (2024). Assessment and analysis of the effects of implementing building information modelling as a lean management tool in construction management. *International Journal of Building Pathology and Adaptation*. https://doi.org/10.1108/ijbpa-08-2023-0118

[4] Al-Ashmori Y, Othman I, Al-Aidrous A-H (2022). Values, challenges, and critical success factors of building information modelling (BIM) in Malaysia: Experts perspective. *Sustainability*, 14(6), Article 3192. https://doi.org/10.3390/su14063192

[5] Ali K, Alhajlah H, Kassem M (2022). Collaboration and risk in building information modelling (BIM): A systematic literature review. *Buildings*, 12(5), Article 571. https://doi.org/10.3390/buildings12050571

[6] Almujibah H (2023). Assessment of building information modeling (BIM) as a time and cost-saving construction management tool: Evidence from two-story villas in Jeddah. *Sustainability*, 15(9), Article 7354. https://doi.org/10.3390/su15097354

[7] Alnaser A, Alsanabani N, Al-Gahtani K (2023). BIM impact on construction project time using system dynamics in Saudi Arabia's construction. *Buildings*, 13(9), Article 2267. https://doi.org/10.3390/buildings13092267

[8] Cao D, Wang G, Li H, Skitmore M, Huang T, Zhang W (2015). Practices and effectiveness of building information modelling in construction projects in China. *Automation in Construction*, 49, 113–122. https://doi.org/10.1016/j.autcon.2014.10.014

[9] Chan D, Olawumi T, Ho A (2019). Perceived benefits of and barriers to building information modelling (BIM) implementation in construction: The case of Hong Kong. *Journal of Building Engineering*, Article 100764. https://doi.org/10.1016/j.jobe.2019.100764

[10] Datta SD, Sobuz MHR, Mim NJ, Nath AD (2023). Investigation on the effectiveness of using building information modeling (BIM) tools in project management: A case study. *Revista de la Construcción*, 22(2). https://doi.org/10.7764/rdlc.22.2.306

[11] Farouk A, Rahman R (2023). Integrated applications of building information modeling in project cost management: A systematic review. *Journal of Engineering, Design and Technology*. https://doi.org/10.1108/jedt-10-2022-0538

[12] Georgiadou M (2019). An overview of benefits and challenges of building information modelling (BIM) adoption in UK residential projects. *Construction Innovation*. https://doi.org/10.1108/ci-04-2017-0030

[13] Huang Y, Wu L, Chen J, Lu H, Xiang J (2022). Impacts of building information modelling (BIM) on communication network of the construction project: A social capital perspective. *PLOS ONE*, 17. https://doi.org/10.1371/journal.pone.0275833

[14] Ibrahim AS, Abdul-Hameed TA, Morakinyo KO, Taiwo RO (2025). Building information modelling (BIM) usage among construction professionals in Lagos State, Nigeria. *Local Engineering*, 3(1), 7–16.

[15] Latupeirissa J, Arrang H (2024). Sustainability factors of building information modeling (BIM) for a successful construction project management life cycle in Indonesia. *Journal of Building Pathology and Rehabilitation*, 9. https://doi.org/10.1007/s41024-023-00376-1

[16] Liu Y, van Nederveen S, Hertogh M (2017). Understanding effects of BIM on collaborative design and construction: An empirical study in China. *International Journal of Project Management*, 35, 686–698. https://doi.org/10.1016/j.ijproman.2016.06.007

[17] Mohammed HS, Hilal M (2024). Improving building information modeling (BIM) implementation throughout the construction industry. *Journal of Engineering*. https://doi.org/10.31026/j.eng.2024.02.06

[18] Nsimbe A, Di J (2024). The impact of building information modeling technology on cost management of civil engineering projects: A case study of the Mombasa Port Area Development Project. *Buildings*, 14(4), Article 1175. https://doi.org/10.3390/buildings14041175

[19] Okwe EI, Olanrewaju OI, Heckman M, Chileshe N (2023). Barriers to building information modelling and facility management practices integration in Nigeria. *Journal of Facilities Management*, 21(5), 845–865.

[20] Olanrewaju OI, Babarinde SA, Chileshe N, Sandanayake M (2021). Drivers for implementation of building information modeling (BIM) within the Nigerian construction industry. *Journal of Financial Management of Property and Construction*, 26(3), 366–386.

[21] Olawumi T, Chan D (2019). Building information modelling and project information management framework for construction projects. *Journal of Civil Engineering and Management*. https://doi.org/10.3846/jcem.2019.7841

[22] Parsamehr M, Perera U, Dodanwala T, Perera P, Ruparathna R (2023). A review of construction management challenges and BIM-based solutions: Perspectives from the schedule, cost, quality, and safety management. *Asian Journal of Civil Engineering*, 24, 353–389. https://doi.org/10.1007/s42107-022-00501-4

[23] Raza MS, Tayeh B, Maglad A (2023). Potential features of building information modeling (BIM) for application of project management knowledge areas in the construction industry. *Heliyon*, 9, Article e19697. https://doi.org/10.1016/j.heliyon.2023.e19697

[24] Rogers EM (2003). Diffusion of innovations (5th ed.). *Free Press*.

[25] Sampaio A, Azevedo G, Gomes A (2023). BIM manager role in the integration and coordination of construction projects. *Buildings*, 13(8), Article 2101. https://doi.org/10.3390/buildings13082101

[26] Sarvari H, Chan D, Rakhshanifar M, Banaitienė N, Banaitis A (2020). Evaluating the impact of building information modeling (BIM) on mass house building projects. *Buildings*, 10(2), Article 35. https://doi.org/10.3390/buildings10020035

[27] Thaheem MJ, Nasir AR, Khan KIA (2020). Project schedule risk management through building information modelling. *International Journal of Construction Management*, 22, 1489–1499. https://doi.org/10.1080/15623599.2020.1728606

[28] Tornatzky LG, Fleischer M (1990). The processes of technological innovation. *Lexington Books*.

[29] Trist EL, Bamforth KW (1951). Some social and psychological consequences of the longwall method of coal-getting. *Human Relations*, 4(1), 3–38.

[30] Wang T, Chen H (2023). Integration of building information modeling and project management in construction project life cycle. *Automation in Construction*, Article 104832. https://doi.org/10.1016/j.autcon.2023.104832

[31] Waqar A, Mansoor MS (2024). Building information modeling (BIM) implementation and construction project success in Malaysian construction industry: Mediating role of project control. *Engineering, Construction and Architectural Management*. https://doi.org/10.1108/ecam-08-2023-0794

[32] Waqar A, Othman I, Radu D, Ali Z, Almujibah H, Hadzima-Nyarko M, Khan MB (2023). Modeling the relation between building information modeling and the success of construction projects: A structural-equation-modeling approach. *Applied Sciences*, 13(15), Article 9018. https://doi.org/10.3390/app13159018

[33] Ye Z, Antwi-Afari M, Tezel A, Manu P (2024). Building information modeling (BIM) in project management: A bibliometric and science mapping review. *Engineering, Construction and Architectural Management*. https://doi.org/10.1108/ecam-04-2023-0355