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Building Information Modelling (BIM) Adoption and Project Delivery Efficiency Among Selected Counties in Kenya

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ABSTRACT: This study examined the effect of Building Information Modelling (BIM) adoption on project delivery efficiency in the construction industry within the Nairobi Metropolitan Region, Kenya. Although BIM has become a globally recognized approach for improving construction project performance, its adoption in Kenya has remained limited and fragmented. The study focused on five key dimensions of BIM adoption: awareness and knowledge, technology infrastructure, perceived benefits, collaboration and information sharing, and organizational adoption. A descriptive research design was adopted, and systematic probability sampling was used to select respondents from five counties within the Nairobi Metropolitan Region. From the target population, a sample size of 384 respondents was determined using statistical sampling formulas for large populations. Primary data were collected through structured questionnaires containing both open-ended and closed-ended questions. Quantitative data were analyzed using descriptive statistics, correlation analysis, and multiple regression techniques. A pilot study involving 38 respondents was conducted to assess the validity and reliability of the research instruments. The findings revealed that all the examined BIM dimensions had positive and statistically significant effects on project delivery efficiency. The study established that BIM improved cost control, time management, quality outcomes, stakeholder coordination, and decision-making efficiency through enhanced collaboration and reduced project rework. However, challenges such as high software acquisition costs and the absence of a national BIM policy framework hindered wider implementation. The study concluded that successful BIM adoption requires strong organizational support, technological readiness, and enabling policy frameworks. It recommended development of a national BIM regulatory framework, integration of BIM into public procurement systems, and increased investment in technical training programs.

KEYWORDS: Building Information Modelling, Project Delivery Efficiency, Digital Transformation, Construction Industry, Technology Infrastructure

INTRODUCTION

Background of the Study

Building Information Modelling (BIM) has become an important innovation in the global construction industry due to its ability to improve project delivery efficiency through enhanced coordination, collaboration, visualization, and information management. BIM integrates architectural, engineering, and construction information into a shared digital platform that supports planning, design, construction, and facility management throughout the project lifecycle (Eastman et al., 2020). Globally, the construction industry has increasingly adopted BIM to address persistent challenges such as cost overruns, project delays, design conflicts, poor communication, and inefficient resource utilization. Through real-time information sharing, clash detection, and predictive simulations, BIM improves decision-making and minimizes construction errors, leading to better project outcomes (Azhar, 2021).

Several developed countries have institutionalized BIM through national policies, standards, and mandatory public procurement requirements. The United Kingdom introduced mandatory BIM implementation for centrally procured public projects, resulting in improved efficiency and reduced project costs (Eischet, 2025). Similarly, Singapore implemented a national BIM roadmap supported by financial incentives and digital approval systems, which accelerated adoption across the construction industry. Countries such as Germany, China, and the United States have also integrated BIM into infrastructure and building projects to improve coordination, quality management, and sustainability (Succar & Sher, 2020). These international experiences demonstrate that government support, policy frameworks, training, and technological investment are essential for successful BIM adoption.

In Africa, BIM adoption remains uneven, although some countries have made notable progress. South Africa has emerged as one of the leading adopters due to government initiatives promoting digital transformation in construction projects (Windapo & Cattell, 2021). Nigeria has also experienced gradual BIM uptake, largely driven by private construction firms and universities, despite lacking a comprehensive national BIM policy framework (Oladapo & Oyewobi, 2020). In Ghana and Ethiopia, adoption remains limited because of inadequate technical expertise, poor digital infrastructure, high implementation costs, and limited awareness among industry practitioners (Bokor et al., 2022; Assefa & Gebeyehu, 2021). Across the continent, the lack of supportive regulatory frameworks and capacity-building initiatives continues to hinder widespread BIM implementation, even though the technology offers significant potential for improving project delivery efficiency and sustainable infrastructure development (Brinkerhoff & Brinkerhoff, 2021).

In Kenya, BIM adoption is gradually increasing, especially among large construction firms involved in infrastructure and commercial projects. However, adoption remains fragmented and largely experimental. Studies show that although awareness of BIM is improving, many construction professionals still lack adequate technical knowledge, training, and expertise to implement BIM effectively (Oduor et al., 2024). The Kenyan construction industry continues to face persistent challenges such as project delays, cost overruns, poor stakeholder coordination, communication breakdowns, and frequent rework. These inefficiencies negatively affect project performance and limit the contribution of the construction sector to national development goals under Kenya Vision 2030 and the Bottom-Up Economic Transformation Agenda (BETA).

Several barriers continue to slow BIM adoption in Kenya. One of the major challenges is the absence of a national BIM policy framework or standardized implementation guidelines. Research indicates that government involvement in BIM promotion and regulation remains minimal, leading to fragmented and inconsistent adoption across the industry (Rop et al., 2021). Other barriers include high software acquisition costs, inadequate ICT infrastructure, poor interoperability between systems, limited IT support, and insufficient training opportunities (Kaburo et al., 2018; Afolabi et al., 2024). Resistance to organizational change and low digital readiness among firms also limit effective BIM implementation. Consequently, many construction projects continue to experience inefficiencies that BIM is designed to address.

Despite these challenges, BIM presents significant opportunities for improving project delivery efficiency in Kenya's construction industry. BIM enhances collaboration and information sharing through the use of Common Data Environments (CDEs), where project stakeholders can access and exchange real-time information (Eastman et al., 2020). Standardized formats such as Industry Foundation Classes (IFC) and Construction Operations Building Information Exchange (COBie) improve interoperability and coordination among architects, engineers, contractors, and project managers (Olatunji et al., 2022). BIM also supports accurate cost estimation, schedule planning, quality management, and risk identification, thereby reducing design errors, minimizing rework, and improving stakeholder satisfaction (Marzouk et al., 2022).

The study focused on five key dimensions influencing BIM adoption and project delivery efficiency: awareness and knowledge, technology infrastructure, perceived benefits, collaboration and information sharing, and organizational adoption. Awareness and training improve professionals' competence in BIM usage, while technological infrastructure ensures access to suitable software, hardware, and IT support systems. Perceived benefits such as reduced design clashes, improved decision-making, and predictability in project cost and time motivate firms to adopt BIM (Azhar, 2021). Collaboration and information sharing strengthen interdisciplinary coordination, while organizational adoption reflects management support, BIM policies, and integration of BIM into organizational workflows (Liu et al., 2023).

Although global evidence confirms BIM's transformative role in improving construction performance, empirical studies examining its influence on project delivery efficiency in Kenya remain limited. Existing research has largely focused on awareness and adoption barriers without adequately assessing how BIM dimensions affect project outcomes such as cost performance, schedule adherence, quality management, coordination, and stakeholder satisfaction. This knowledge gap underscores the need for further research to generate context-specific evidence that can guide policymakers, regulators, and construction firms in accelerating BIM adoption and improving project delivery efficiency in Kenya.

Statement of the Problem

Building Information Modelling (BIM) has increasingly been recognized globally as an effective digital solution for improving project delivery efficiency in the construction industry through enhanced coordination, collaboration, cost control, and risk management. Countries that have institutionalized BIM through national policies and standardized implementation frameworks have reported significant improvements in construction performance, including reduced project delays, minimized rework, improved quality, and better stakeholder coordination (Nasila & Cloete, 2018). Despite these global advancements, BIM adoption in Kenya remains slow, fragmented, and largely experimental, even as the country continues to invest heavily in infrastructure and construction projects (Kimani et al., 2020).

Although awareness of BIM is gradually increasing among construction professionals in Kenya, practical implementation remains limited. Research indicates that only about 56.6% of construction practitioners have experimented with BIM tools, while many still lack adequate technical skills, organizational support, and training necessary for effective utilization across the project lifecycle (Oduor et al., 2024). This limited adoption reduces the ability of construction firms to fully benefit from BIM capabilities such as clash detection, real-time collaboration, improved communication, and accurate project visualization.

The absence of a national BIM policy framework and standardized implementation guidelines further contributes to inconsistent adoption across the industry. Government involvement in promoting and regulating BIM remains minimal, resulting in fragmented practices and lack of coordinated digital transformation within the construction sector (Rop et al., 2021). Additional barriers such as high software acquisition costs, inadequate ICT infrastructure, interoperability challenges, and insufficient technical expertise continue to hinder meaningful BIM implementation (Kaburo et al., 2018; Afolabi et al., 2024).

Consequently, Kenya's construction industry continues to experience persistent project delivery inefficiencies, including cost overruns, delays, poor coordination, and frequent rework. Despite global evidence demonstrating BIM's transformative potential, empirical studies examining the relationship between BIM adoption and project delivery efficiency in Kenya remain limited. This knowledge gap restricts the ability of policymakers, regulators, and construction firms to formulate effective strategies for accelerating BIM adoption and improving project performance.

Objective of the Study

The study was guided by four objectives:

i). To assess the influence of awareness and knowledge of BIM on project delivery efficiency in the construction industry within the Nairobi Metropolitan Region, Kenya.

ii). To examine the effect of technology infrastructure on project delivery efficiency in the construction industry within the Nairobi Metropolitan Region, Kenya.

iii). To evaluate the perceived benefits of BIM adoption and their relationship with project delivery efficiency in the construction industry within the Nairobi Metropolitan Region, Kenya.

iv). To determine the effect of collaboration and information sharing through BIM on project delivery efficiency in the construction industry within the Nairobi Metropolitan Region, Kenya.

v). To investigate the influence of organizational adoption of BIM on project delivery efficiency in the construction industry within the Nairobi Metropolitan Region, Kenya.

Research Hypotheses

The study sought to answer the following research questions:

i). **$H_0$1:** Awareness and knowledge of BIM have no significant influence on project delivery efficiency in the construction industry within the Nairobi Metropolitan Region, Kenya.

ii). **$H_0$2:** Technology infrastructure does not have a significant effect on project delivery efficiency in the construction industry within the Nairobi Metropolitan Region, Kenya.

iii). **$H_0$3:** The perceived benefits of BIM adoption are not significantly related to project delivery efficiency in the construction industry within the Nairobi Metropolitan Region, Kenya.

iv). **$H_0$4:** Collaboration and information sharing through BIM have no significant effect on project delivery efficiency in the construction industry within the Nairobi Metropolitan Region, Kenya.

v). **$H_0$5:** Organizational adoption of BIM has no significant influence on project delivery efficiency in the construction industry within the Nairobi Metropolitan Region, Kenya.

REVIEW OF LITERATURE

The study was anchored on five key theories that explain the adoption and influence of Building Information Modelling (BIM) on project delivery efficiency in the construction industry. Diffusion of Innovation (DOI) Theory explains how awareness and knowledge influence BIM adoption through stages such as knowledge, persuasion, decision, implementation, and confirmation (Rogers, 2003). The theory highlights that limited awareness and inadequate technical skills hinder effective BIM utilization and reduce its potential to improve project outcomes (Akinradewo et al., 2022). The Technology-Organization-Environment (TOE) Framework explains how technological infrastructure, organizational readiness, and environmental pressures influence BIM adoption and project delivery efficiency (Tornatzky & Fleischer, 1990). The framework emphasizes that adequate software, hardware, IT support, and institutional support are necessary for successful BIM implementation (Olanrewaju et al., 2023).

The Technology Acceptance Model (TAM) explains how perceived usefulness and ease of use influence users' acceptance of BIM technology (Davis, 1989). Perceived benefits such as reduced design clashes, improved decision-making, and enhanced cost predictability encourage BIM adoption and improve project delivery efficiency (Azhar, 2021). Socio-Technical Systems (STS) Theory focuses on the interaction between social systems and technical systems in improving collaboration and information sharing within BIM-enabled projects (Trist & Emery, 1951). The theory emphasizes that effective coordination among multidisciplinary teams improves communication, reduces rework, and enhances project efficiency (Chong et al., 2023). Finally, the Resource-Based View (RBV) Theory explains organizational adoption of BIM as a strategic resource that enhances competitive advantage and project performance when supported by skilled personnel, leadership commitment, and organizational integration (Barney, 1991; Liu et al., 2023). Collectively, these theories provide a comprehensive framework for understanding how BIM adoption influences project delivery efficiency in the Kenyan construction industry.

Conceptually, the study examined the relationship between BIM adoption dimensions and project delivery efficiency in Kenya's construction industry. The independent variables included awareness and knowledge, technology infrastructure, perceived benefits, collaboration and information sharing, and organizational adoption. These variables influenced the dependent variable, project delivery efficiency, which was measured through stakeholder satisfaction, time performance, cost performance, and scope performance. The framework emphasized that improved BIM awareness, technological readiness, collaboration, organizational support, and recognition of BIM benefits enhance project coordination, reduce delays and rework, improve communication, and strengthen overall construction project performance (Eastman et al., 2020; Azhar, 2021).

Empirical studies globally and locally demonstrate that Building Information Modelling adoption improves project delivery efficiency through enhanced collaboration, visualization, coordination, and information management. Studies show that BIM reduces project delays, cost overruns, design clashes, and rework while improving decision-making and stakeholder communication (Azhar, 2021; Lu et al., 2021). In Kenya, research indicates that limited awareness, inadequate technical expertise, poor ICT infrastructure, and lack of organizational support hinder effective BIM adoption (Kaburo et al., 2018; Oduor et al., 2024). However, firms with adequate technological infrastructure, collaboration systems, and management support experience improved project efficiency, quality outcomes, and cost control (Muriithi & Gitau, 2023).

Conceptual Framework

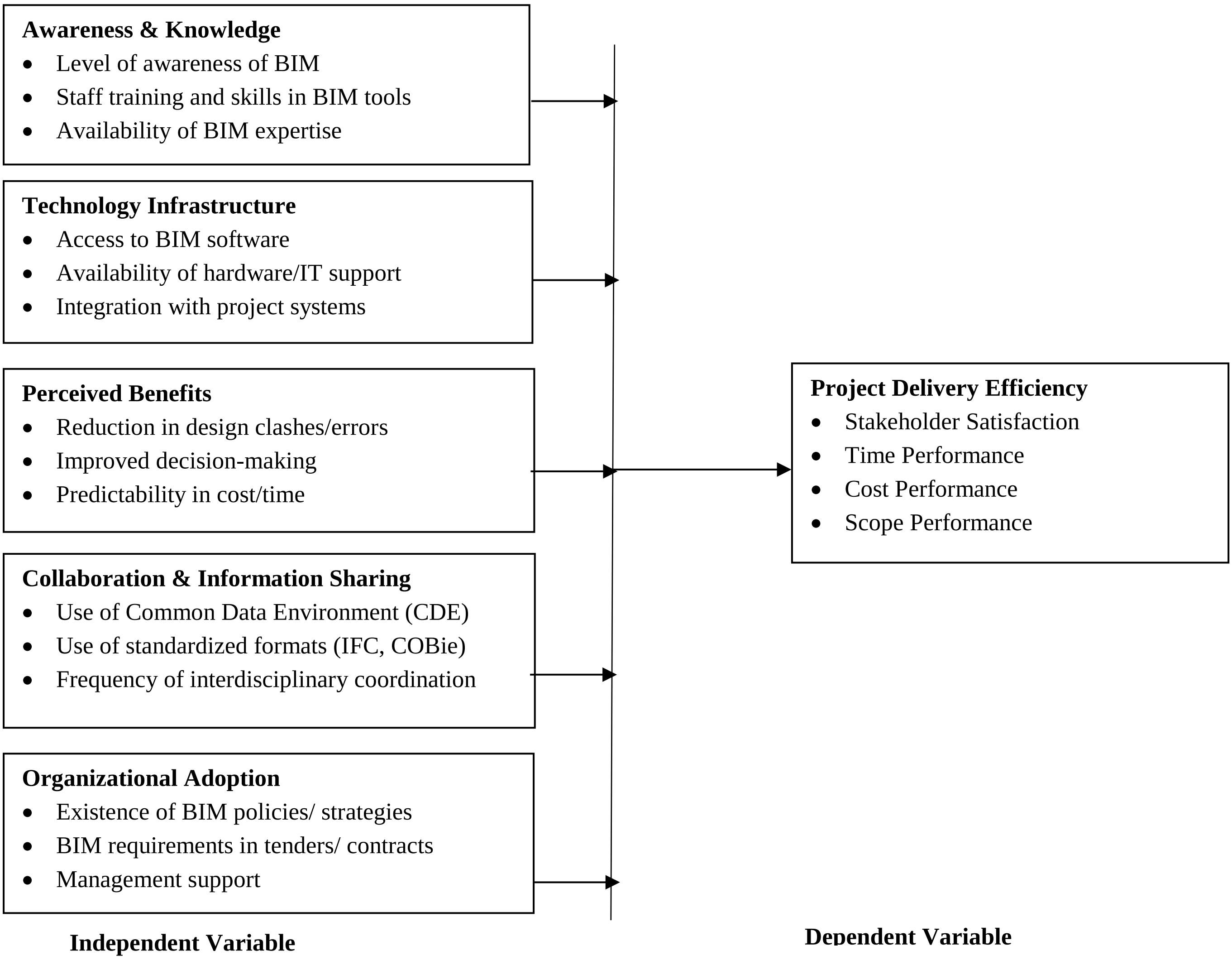

Figure 1: Conceptual Framework

MATERIALS AND METHODS

Research Design

The study adopted a descriptive research design to examine the effect of Building Information Modelling adoption on project delivery efficiency in the construction industry within the Nairobi Metropolitan Region, Kenya. The design was considered appropriate because it enabled the systematic collection, analysis, and interpretation of data on BIM adoption practices and project delivery outcomes without manipulating the study variables (Creswell & Creswell, 2023; Saunders et al., 2023). The approach facilitated the examination of relationships between awareness and knowledge, technology infrastructure, perceived benefits, collaboration and information sharing, organizational adoption, and project delivery efficiency. Additionally, the design supported the use of quantitative techniques such as descriptive statistics, correlation analysis, and multiple regression analysis to establish relationships among the study variables (Sekaran & Bougie, 2022).

Target Population and Sampling Technique

The target population comprised 10,477,046 key stakeholders in the construction industry within the Nairobi Metropolitan Region (KNBS, 2025), including construction firms, architects, engineers, quantity surveyors, project managers, consultants, contractors, and regulatory bodies involved in BIM implementation and project delivery. The study focused on respondents from five counties within the Nairobi Metropolitan Region due to their high concentration of infrastructure and construction projects. Systematic probability sampling was used to select respondents from the sampling frame to ensure fairness and reduce sampling bias. A sample size of 384 respondents was determined using Bell, Brymann and Harley (2018) statistical sampling formula for large populations, enabling the study to obtain reliable and representative data for analysis.

Instrumentation and Data Collection Procedure

The study utilized structured questionnaires as the primary data collection instrument to gather information from construction industry stakeholders within the Nairobi Metropolitan Region, Kenya. The questionnaire contained both closed-ended and open-ended questions designed to capture data on the key dimensions of Building Information Modelling adoption, including awareness and knowledge, technology infrastructure, perceived benefits, collaboration and information sharing, organizational adoption, and project delivery efficiency. Closed-ended items enabled the collection of quantitative data suitable for statistical analysis, while open-ended questions provided respondents with opportunities to give additional insights and explanations. The questionnaire approach was considered appropriate because it allowed the collection of standardized information from a large number of respondents efficiently and cost-effectively (Creswell & Creswell, 2023; Saunders et al., 2023).

A pilot study involving 38 respondents, representing 10% of the sample size, was conducted before the main data collection exercise to assess the validity and reliability of the research instrument. The pilot study helped identify ambiguities, inconsistencies, and weaknesses in the questionnaire, enabling refinement of the instrument before full-scale administration. Validity, which refers to the extent to which the results derived from data analysis accurately reflect the phenomenon being investigated (Kimaku, 2021), was examined through expert review and factor analysis to ensure that the questionnaire accurately measured the intended study variables (Sekaran & Bougie, 2022), while reliability was assessed using Cronbach's alpha coefficients.

Data analysis

Data analysis was conducted using both descriptive and inferential statistical techniques with the aid of the Statistical Package for the Social Sciences (SPSS). Descriptive statistics, including frequencies, percentages, means, and standard deviations, were applied to summarize the demographic characteristics of respondents and the study variables (Pallant, 2020). Inferential statistics comprised Pearson correlation and multiple regression analyses, which were employed to examine the relationship between Building Information Modelling (BIM) adoption and project delivery efficiency in the construction industry within the Nairobi Metropolitan Region, Kenya.

Multiple regression model; $\mathbf{Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \mathscr{E}}$ was estimated to test the study hypotheses and assess the significance of predictor variables. Diagnostic tests which included normality, heteroscedasticity, multicollinearity, and linearity tests were conducted to ensure the validity and strength of the regression model (Gujarati & Porter, 2021; Hair et al., 2020).

Ethical Considerations

Ethical clearance for the study was granted by the Ethics Review Committee of Taita Taveta University. Participation in the research was entirely voluntary, and informed consent was obtained from all participants prior to their involvement in the study. To ensure confidentiality and anonymity, unique identification codes were used, while all collected data were securely stored under restricted access. In addition, enumerators conducted themselves with professionalism, integrity, and respect throughout their engagement with respondents during the data collection exercise.

RESULTS

A total of 384 questionnaires were issued to respondents, with 345 filled and returned while 39 were unreturned. The returned questionnaires formed a response rate of 89.7% as revealed in Table 1.

Table 1: Response Rate

Questionnaire	Frequency	Percent
Returned	345	89.7
Non-returned	39	10.3
Total	**384**	**100.0**

Demographic Information Analysis

Table 2: Demographic Data

Variable	Category	Frequency (f)	Percentage (%)
Gender	Male	242	70.1
	Female	103	29.9
Age (Years)	Below 30	78	22.6
	30–39	141	40.9
	40–49	92	26.7
	50 and above	34	9.8
Education Level	Diploma	61	17.7
	Bachelor's Degree	163	47.2
	Master's Degree	102	29.6
	PhD	11	3.2
	Other	8	2.3
Profession	Engineer	112	32.5
	Architect	69	20.0
	Quantity Surveyor	58	16.8
	Contractor	54	15.7
	Project Manager	41	11.9

Variable	Category	Frequency (f)	Percentage (%)
	Other	11	3.1
Work Experience (Years)	Less than 3	63	18.3
	3–5	91	26.4
	6–10	119	34.5
	Above 10	72	20.8
Organization Type	Private Firm	149	43.2
	Consultancy	83	24.1
	Contractor	69	20.0
	Public Sector	44	12.8

Key Findings

The descriptive analysis findings indicated that respondents generally agreed that Building Information Modelling (BIM) adoption positively influenced project delivery efficiency in the construction industry within the Nairobi Metropolitan Region, Kenya. On awareness and knowledge, most respondents acknowledged that BIM awareness within their organizations had increased and that staff training and technical skills contributed significantly to effective BIM implementation. Respondents further agreed that the availability of BIM expertise improved project coordination, communication, and problem-solving during project execution.

Regarding technology infrastructure, the findings showed that access to BIM software, hardware, and IT support played a major role in enhancing project delivery efficiency. Respondents indicated that firms with adequate technological infrastructure experienced better project planning, improved data management, and reduced design errors. However, some respondents highlighted challenges associated with high software acquisition costs and limited ICT infrastructure, especially among smaller firms. On perceived benefits, respondents strongly agreed that BIM adoption reduced design clashes and rework, improved decision-making, and enhanced predictability in project cost and time performance. BIM was also perceived to improve visualization, communication among stakeholders, and quality management, thereby contributing to improved project outcomes.

The findings on collaboration and information sharing revealed that the use of Common Data Environments (CDEs), standardized data exchange formats, and frequent interdisciplinary coordination enhanced communication and teamwork among project participants. Respondents agreed that BIM improved real-time information sharing, reduced misunderstandings, and strengthened coordination between architects, engineers, contractors, and project managers. Concerning organizational adoption, the study established that management support, existence of BIM policies, and inclusion of BIM requirements in contracts and tender documents positively influenced implementation. Firms with stronger organizational commitment to BIM reported improved stakeholder satisfaction, better cost control, timely project completion, and enhanced scope performance. Overall, the descriptive findings confirmed that BIM adoption significantly contributed to improved project delivery efficiency across multiple performance dimensions in Kenya's construction industry.

Table 3: Awareness and Knowledge results

Statements on Awareness and Knowledge	SD	D	N	A	SA	Mean	SD
I am aware of what BIM entails.	11	11	15	35	28	**3.59**	**1.30**
I understand BIM processes and workflows.	0	3	16	45	36	**4.16**	**0.78**
I have received adequate BIM training.	6	8	10	39	37	**3.93**	**1.15**
I can interpret BIM models accurately.	5	7	8	32	48	**4.11**	**1.13**
I understand BIM software functionalities.	5	5	8	36	46	**4.13**	**1.09**
I can collaborate using BIM tools.	5	9	11	33	42	**3.96**	**1.21**
My organization provides BIM awareness programs.	7	6	10	31	46	**4.02**	**1.20**
AVERAGE	**5.6**	**7**	**11.1**	**35.9**	**40.4**	**3.99**	**1.12**

Table 4: Technology Infrastructure Results

Statements on Technology Infrastructure	SD	D	N	A	SA	Mean	SD
My organization has the required BIM hardware.	2	12	18	31	37	**3.89**	**1.10**
We have updated BIM software licenses.	6	11	14	28	41	**3.88**	**1.22**
Internet strength supports BIM operations.	4	8	13	33	42	**4.01**	**1.11**
We have reliable digital storage for BIM files.	7	3	8	33	49	**4.15**	**1.13**
IT staff support BIM-related issues effectively.	4	10	9	33	44	**4.04**	**1.14**
Software/hardware upgrades are done regularly.	3	8	13	32	44	**4.06**	**1.09**

Our BIM systems integrate well with existing tools.	2	7	12	31	48	**4.15**	**1.03**
We have sufficient servers/cloud space for BIM models.	5	6	12	36	41	**4.01**	**1.12**
Technical failures rarely disrupt BIM usage.	5	7	17	30	41	**3.95**	**1.15**
AVERAGE	**4.2**	**8.1**	**12.9**	**31.9**	**43.0**	**4.02**	**1.12**

Table 5: Perceived Benefits Results

Statements on Perceived Benefits	**SD**	**D**	**N**	**A**	**SA**	**Mean**	**SD**
BIM reduces design clashes significantly.	0	10	12	38	40	**4.08**	**0.96**
BIM enhances visualization of project designs.	2	11	9	40	38	**4.03**	**1.03**
BIM improves decision-making accuracy.	2	8	10	37	43	**4.11**	**1.02**
BIM enhances scheduling and time planning.	2	7	9	38	44	**4.17**	**0.96**
BIM improves cost estimation accuracy.	2	8	10	32	48	**4.16**	**1.02**
BIM minimizes rework in construction.	3	8	26	19	44	**3.92**	**1.15**
BIM contributes to higher project quality.	2	7	14	16	61	**4.26**	**1.08**
BIM increases productivity across teams.	5	10	12	15	58	**4.11**	**1.24**
BIM improves risk prediction and mitigation.	2	12	13	19	54	**4.11**	**1.17**
AVERAGE	**2.2**	**9.0**	**12.8**	**28.2**	**47.8**	**4.11**	**1.07**

Table 6: Collaboration and information sharing results

Statements on Collaboration and information sharing	**SD**	**D**	**N**	**A**	**SA**	**Mean**	**SD**
BIM promotes teamwork across project disciplines.	1	1	11	49	38	**4.24**	**0.73**
We share BIM models in real-time.	5	11	14	37	33	**3.84**	**1.13**
A Common Data Environment (CDE) is used effectively.	1	7	8	41	43	**4.18**	**0.93**
BIM reduces communication conflicts.	2	10	10	35	43	**4.06**	**1.06**
BIM enhances transparency among stakeholders.	4	9	8	36	43	**4.12**	**0.97**
BIM improves interdisciplinary coordination.	1	7	10	39	43	**4.15**	**0.95**
BIM enhances accountability during construction phases.	2	8	13	34	43	**4.09**	**1.02**
Stakeholder collaboration improves when BIM is used.	3	12	14	36	35	**3.87**	**1.11**
AVERAGE	**2.4**	**8.1**	**11**	**38.4**	**40.1**	**4.07**	**0.99**

Table 7: Organizational Adoption of BIM results

Statements on Organizational Adoption of BIM	**SD**	**D**	**N**	**A**	**SA**	**Mean**	**SD**
Management supports BIM adoption fully.	0	3	16	44	37	**4.14**	**0.8**
There is a clear BIM implementation strategy.	1	1	15	45	38	**4.25**	**0.69**
The organization invests in BIM training programs.	3	11	16	38	32	**3.86**	**1.09**
We have dedicated BIM personnel/teams.	6	8	10	30	46	**4.03**	**1.17**
Policies support BIM workflows and standards.	3	9	37	37	14	**3.50**	**0.96**
Collaboration and information sharing embraces digital innovation.	36	18	27	9	10	**2.39**	**1.33**
Resources are allocated for BIM adoption.	2	4	12	16	66	**4.41**	**0.98**
BIM goals are included in our strategic plans.	16	13	39	8	24	**3.10**	**1.35**
There is a roadmap for future BIM integration.	31	13	18	14	24	**2.86**	**1.57**
AVERAGE	**10.9**	**8.9**	**21.1**	**26.8**	**32.3**	**3.62**	**1.10**

Correlation Analysis

Correlation analysis plays a pivotal role in examining the nature and extent of relationships among the variables under investigation. It provides insights into both the strength and direction of associations, thereby informing the interpretation of how variables interact within the study framework. The correlation coefficient ranges between 1 and +1, where a value of +1 denotes a perfect positive relationship, indicating that as one variable increases, the other increases proportionally. Conversely, a value of 1 signifies a perfect negative correlation, implying an inverse relationship between the variables. A value of 0.000 shows the absence of any relationship. Correlation coefficients ranging from 0.001–0.250

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reflect a weak association, 0.251–0.500 indicate a moderately strong relationship, 0.501–0.750 denote a strong correlation, and 0.751–1.000 represent a robust correlation.

Table 8: Correlation Matrix for Study Variables

Correlations		Y	X1	X2	X3	X4	X5
Y	Pearson Correlation	1					
	Sig. (2-tailed)						
X1	Pearson Correlation	.651**	1				
	Sig. (2-tailed)	0.000					
X2	Pearson Correlation	.680**	.532**	1			
	Sig. (2-tailed)	0.003	0.009				
X3	Pearson Correlation	.612**	.360**	.444**	1		
	Sig. (2-tailed)	0.021	0.001	0.000			
X4	Pearson Correlation	.678**	.393**	.457**	.506**	1	
	Sig. (2-tailed)	0.000	0.001	0.001	0.000		
X5	Pearson Correlation	.470**	.374**	.356**	.320**	.296**	1
	Sig. (2-tailed)	0.000	0.000	0.068	0.000	0.001	

Where: Y = project delivery efficiency, X1 = awareness and knowledge, X2 = technology infrastructure, X3 = perceived benefits of BIM adoption, X4 = collaboration and information sharing, X5 = organizational adoption of BIM

The correlation analysis findings revealed that all the dimensions of Building Information Modelling (BIM) adoption had positive and statistically significant relationships with project delivery efficiency in the construction industry within the Nairobi Metropolitan Region, Kenya. The results indicated that awareness and knowledge of BIM were positively correlated with project delivery efficiency, implying that increased staff training, technical expertise, and understanding of BIM concepts enhanced project coordination, reduced errors, and improved overall project performance. These findings support previous studies which established that BIM knowledge and professional competence are critical drivers of successful implementation and improved construction outcomes (Oduor et al., 2024; Olanrewaju et al., 2023). Technology infrastructure also showed a strong positive correlation with project delivery efficiency. Firms with adequate access to BIM software, hardware, IT support, and integrated project systems experienced improved planning, communication, and cost management. The findings align with studies by Olatunji et al. (2022) and Marzouk et al. (2022), which observed that robust technological infrastructure enhances BIM functionality and improves project execution efficiency.

The analysis further revealed that perceived benefits of BIM adoption, including reduced design clashes, improved decision-making, and better predictability of cost and time, were positively associated with project delivery efficiency. This implies that organizations recognizing the practical value of BIM are more likely to achieve improved project performance outcomes (Azhar, 2021). Similarly, collaboration and information sharing through Common Data Environments (CDEs) and standardized information exchange formats showed a significant positive relationship with project delivery efficiency. Enhanced interdisciplinary coordination and real-time communication reduced misunderstandings and minimized project delays (Chong et al., 2023). Finally, organizational adoption demonstrated a strong positive correlation with project delivery efficiency. Firms with supportive management, BIM policies, and contractual BIM requirements reported improved stakeholder satisfaction, quality performance, and project coordination. These findings are consistent with Liu et al. (2023), who established that organizational commitment significantly influences successful BIM implementation and construction project performance.

Regression Analysis

The univariate regression analysis findings revealed that each dimension of Building Information Modelling (BIM) adoption had a positive and statistically significant effect on project delivery efficiency in the construction industry within the Nairobi Metropolitan Region, Kenya. The results showed that awareness and knowledge significantly improved project delivery efficiency by enhancing technical competence, reducing errors, and improving coordination among project stakeholders. Similarly, technology infrastructure positively influenced project performance through improved access to BIM software, hardware, IT support, and integrated project systems. These findings support previous studies which established that technological readiness and BIM expertise enhance construction efficiency and reduce project delays and cost overruns (Olanrewaju et al., 2023; Olatunji et al., 2022).

The regression results further indicated that perceived benefits of BIM adoption significantly enhanced project delivery efficiency. Respondents acknowledged that BIM reduced design clashes, improved decision-making, and enhanced predictability in project cost and time performance. Collaboration and information sharing also had a statistically significant positive effect on project delivery efficiency through improved communication, real-time data sharing, and interdisciplinary coordination. These findings are consistent with studies by Azhar (2021) and Chong et al. (2023), which found that BIM-enabled collaboration and information exchange improve project coordination and minimize rework.

The multivariate regression model showed that all the BIM adoption dimensions jointly explained a significant proportion of variation in project delivery efficiency. The model confirmed that awareness and knowledge, technology infrastructure, perceived benefits, collaboration and information sharing, and organizational adoption collectively contributed to improved stakeholder satisfaction, time performance, cost performance, and scope management. Among the variables, organizational adoption and collaboration and information sharing emerged as some of the strongest predictors of project delivery efficiency, emphasizing the importance of management support, BIM policies, and integrated communication systems. The findings align with Liu et al. (2023) and Marzouk et al. (2022), who established that successful BIM implementation depends on both technological capability and strong organizational commitment.
The model summary results are presented in Table 9.

Table 9: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.858a	0.735	0.729	0.223

Table 10: ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Regression	24.23	4	6.058	121.574	.000
Residual	8.72	341	0.050		
Total	32.95	345			

The ANOVA results show that the regression model is statistically significant ($F = 121.574$, $p<0.001$), indicating that the independent variables collectively predict the project delivery efficiency. The large F-value suggests that the variance explained by the model is substantially greater than the unexplained variance. The low p-value ($p < 0.01$) supports rejecting the null hypothesis, confirming that at least one of the predictors significantly contributes to explaining project delivery efficiency outcomes. Therefore, the ANOVA confirms that the regression model is appropriate for testing the study hypotheses.

Table 10: Regression Coefficient Results

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	0.658	0.221		2.982	0.003
Awareness and knowledge	0.263	0.042	0.297	6.319	0.000
Technology infrastructure	0.287	0.051	0.342	5.599	0.001
Perceived Benefits	0.241	0.052	0.217	4.604	0.000
Collaboration and information sharing	0.344	0.056	0.325	6.794	0.015
Organizational Adoption	0.484	0.0126	0.125	2.974	0.000

The regression coefficients table explains the extent to which each independent variable influenced project delivery efficiency while controlling for the effects of the other variables in the model. In this study, the positive regression coefficients indicated that increases in the dimensions of Building Information Modelling (BIM) adoption led to corresponding improvements in project delivery efficiency within the construction industry in the Nairobi Metropolitan Region, Kenya. The coefficient for awareness and knowledge showed a positive and statistically significant relationship with project delivery efficiency. This implies that increased BIM awareness, staff training, and technical expertise improved project coordination, reduced design errors, and enhanced overall project performance. Therefore, organizations with knowledgeable and well-trained personnel were more likely to achieve efficient project delivery outcomes.
Technology infrastructure also recorded a positive and significant coefficient, indicating that access to BIM software, hardware, IT support, and integrated digital systems significantly enhanced project efficiency. This suggests that firms with stronger technological capacity experienced better planning, communication, data management, and reduced project delays. Adequate infrastructure therefore played a critical role in supporting effective BIM implementation. The coefficient for perceived benefits was positive and statistically significant, implying that when construction professionals recognized BIM benefits such as improved decision-making, reduced rework, and predictability in cost and time performance, project delivery efficiency improved significantly. This demonstrates that positive perceptions towards BIM encouraged effective utilization of the technology.
Collaboration and information sharing also had a positive and significant effect on project delivery efficiency. The findings indicate that the use of Common Data Environments (CDEs), standardized information exchange systems, and interdisciplinary coordination enhanced communication among stakeholders, minimized misunderstandings, and improved project execution. Similarly, organizational adoption recorded a positive and significant coefficient, suggesting that management support, existence of BIM policies, and integration of BIM requirements into contracts and

workflows significantly improved project performance. Organizations that institutionalized BIM practices experienced better stakeholder satisfaction, quality outcomes, and overall project efficiency.

The significance values (p-values) for all variables were below the acceptable threshold of 0.05, indicating that the relationships observed were statistically significant and unlikely to have occurred by chance (Saunders et al., 2023). Overall, the regression coefficients confirmed that BIM adoption dimensions significantly and positively influenced project delivery efficiency in Kenya's construction industry.

The overall model becomes:

$$\mathbf{Y = 0.658 + 0.263X_1 + 0.287X_2 + 0.241X_3 + 0.344X_4 + 0.484X_5}$$

Interpretation of Findings

The study findings established that Building Information Modelling (BIM) adoption significantly improved project delivery efficiency in the construction industry within the Nairobi Metropolitan Region, Kenya. The descriptive, correlation, and regression analyses confirmed that awareness and knowledge, technology infrastructure, perceived benefits, collaboration and information sharing, and organizational adoption all had positive and statistically significant effects on project performance. Increased BIM awareness and technical expertise enhanced coordination and reduced project errors, while adequate technological infrastructure improved planning, communication, and cost management. Perceived benefits such as reduced design clashes, improved decision-making, and predictability in project cost and time encouraged BIM utilization and enhanced efficiency outcomes. Collaboration through Common Data Environments (CDEs) and standardized information exchange improved stakeholder coordination and minimized rework. Additionally, management support and organizational BIM policies strengthened implementation and improved stakeholder satisfaction, quality performance, and project completion timelines (Azhar, 2021; Olatunji et al., 2022; Liu et al., 2023; Chong et al., 2023).

Practical Implications

The study demonstrates that adoption of Building Information Modelling can significantly improve project delivery efficiency through enhanced coordination, reduced rework, improved cost control, and timely project completion. The findings provide practical guidance to construction firms, policymakers, and regulatory agencies on the need to invest in BIM training, technological infrastructure, and organizational support systems. The study also highlights the importance of establishing national BIM frameworks and integrating BIM requirements into procurement and project management practices.

Theoretical Implications

The study contributes to existing knowledge on Building Information Modelling adoption by validating the relevance of Diffusion of Innovation Theory, Technology-Organization-Environment Framework, Technology Acceptance Model, Socio-Technical Systems Theory, and Resource-Based View Theory in explaining project delivery efficiency within the Kenyan construction industry. The findings extend these theories by demonstrating that technological readiness, organizational support, collaboration, and user perceptions collectively influence BIM implementation and construction project performance in developing economies.

Limitations of the Descriptive Analysis

The descriptive analysis was limited by its reliance on respondents' perceptions and self-reported information, which may have introduced response bias and subjectivity. Some respondents may have overstated or understated the extent of Building Information Modelling adoption and its influence on project delivery efficiency. Additionally, the analysis focused mainly on summarizing trends and patterns without establishing causal relationships among variables. The study was also confined to selected counties within the Nairobi Metropolitan Region, limiting the generalizability of findings to other regions in Kenya. Furthermore, varying levels of BIM knowledge among respondents may have affected the consistency and accuracy of responses provided.

CONCLUSIONS AND RECOMMENDATIONS

The study concludes that Building Information Modelling (BIM) adoption significantly enhances project delivery efficiency in the construction industry within the Nairobi Metropolitan Region, Kenya. The findings established that awareness and knowledge development, technology infrastructure, perceived benefits, collaboration and information sharing, and organizational adoption all positively and significantly influence project performance. Increased BIM awareness, continuous training, and capacity-building initiatives improve technical competence, strengthen coordination among project stakeholders, and reduce design errors and project delays. Similarly, access to BIM-compatible software and hardware, reliable internet connectivity, and effective IT support improves workflow integration, communication, cost control, and overall project execution efficiency.

The study further established that perceived BIM benefits, including improved visualization, reduced design clashes, enhanced decision-making, and predictability in project cost and time, encourage wider adoption and utilization of BIM technologies. Collaboration and information sharing through Common Data Environments (CDEs) and standardized data exchange systems enhance interdisciplinary coordination, minimize rework, and accelerate decision-making processes. Organizational adoption emerged as the strongest predictor of project delivery efficiency, demonstrating that management support, strategic BIM policies, dedicated BIM teams, and integration of BIM into organizational workflows are essential for sustainable implementation and improved project outcomes. However, the study identified major barriers to BIM implementation, including high software acquisition costs, inadequate ICT infrastructure, limited technical expertise, and the absence of a comprehensive national BIM policy framework.

Based on these findings, the study recommends that the Government of Kenya, regulatory agencies, and professional bodies establish a national BIM implementation and regulatory framework to standardize BIM adoption across the construction sector. Construction firms should invest in continuous professional training, BIM-compatible technologies, and strong digital infrastructure to enhance implementation capacity. Educational institutions should integrate BIM into construction-related curricula, while industry stakeholders should promote collaboration through standardized digital platforms, benchmarking initiatives, and knowledge-sharing programs. In addition, BIM requirements should be integrated into public procurement systems and construction contracts to accelerate digital transformation and improve project delivery efficiency within Kenya's construction industry.

Future Research Directions

Future studies should expand the investigation of Building Information Modelling adoption beyond the Nairobi Metropolitan Region to include other counties and rural construction contexts in Kenya for broader generalization of findings. Further research should also examine the long-term impact of BIM adoption on project sustainability, environmental performance, and lifecycle cost management. Comparative studies between public and private sector construction projects may provide deeper insights into differences in BIM implementation and project delivery outcomes. In addition, future researchers should explore the moderating role of government policy, organizational culture, and digital transformation readiness on BIM adoption and project performance. Studies using mixed-methods or longitudinal research designs are also recommended to provide more comprehensive evidence on causal relationships, implementation challenges, and evolving technological trends influencing BIM adoption in developing construction industries.

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RECOGNITIONS OF THE AUTHOR CONTRIBUTION

Erick Odhiambo Okello - Conceptualization, methodology, data collection, data analysis, writing.

Patrick Mutua Kimaku - Supervision, refining methodology, reviewing and editing.

Eunice Mutisya - Supervision, validation, editing and reviewing.

DATA AVAILABILITY

Due to confidentiality considerations, the full dataset is not publicly available. Nevertheless, anonymized data and relevant supporting materials may be accessed from the corresponding author upon reasonable request.

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