

# The Influence of Technology-Driven Construction Management Practices on Sustainable Building Performance

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## ABSTRACT

This study examined the influence of technology-driven construction management practices on sustainable building performance in Ghana's construction industry. The study was motivated by growing concerns over cost overruns, construction waste, weak project monitoring, fragmented coordination, and limited digital maturity in building project delivery. A quantitative research approach grounded in positivist philosophy was adopted, using a structured questionnaire to collect data from 100 construction professionals in Kumasi. The respondents included project managers, contractors, quantity surveyors, consultants, architects, engineers, and client representatives. Data were analysed using descriptive statistics to determine the extent of adoption and perceived influence of digital construction management practices. The findings revealed that leadership readiness and digital system integration were strongly recognised as drivers of technology adoption, although inadequate digital infrastructure and limited technical skills remained major constraints. The results further showed that real-time financial monitoring, digital collaboration, 5D cost modelling, automated clash detection, just-in-time logistics, IoT-based material tracking, and 4D scheduling significantly improved cost efficiency, waste reduction, and project control performance. The study concludes that digital construction management is not merely an operational efficiency tool but a strategic pathway for achieving cost-effective, resource-efficient, and sustainably managed building projects.

**Keywords:** Technology-Driven Construction Management; Sustainable Building Performance; Digital Construction; Cost Efficiency; Construction Waste Reduction; Project Control; Building Information Modelling.

## INTRODUCTION

Technology-driven construction management has become central to contemporary debates on sustainable building performance, as the construction sector continues to face persistent concerns about cost overruns, waste generation, inefficient resource use, fragmented coordination, and weak project control (Adejola and Nwobodo-Anyadiiegwu, 2025). Sustainable building performance is now understood to encompass more than energy efficiency alone; it includes life-cycle efficiency, cost-effectiveness, waste minimisation, environmental protection, occupant wellbeing, and long-term asset resilience (Firoozi et al., 2025; Olabi et al., 2024). In this context, digital technologies such as Building Information Modelling, the Internet of Things, artificial intelligence, cloud-based platforms, digital twins, and data analytics are increasingly reshaping how construction projects are planned, monitored, and delivered (Naji et al., 2024; Rinchen et al., 2024). These technologies support real-time information sharing, predictive decision-making, integrated cost control, material tracking, and performance monitoring, thereby offering practical pathways to improve sustainability outcomes in building projects.

Despite growing scholarly attention, existing studies remain fragmented in their explanations of how technology-driven construction management practices directly influence sustainable building performance. Much of the literature examines digital technology adoption, cost efficiency, waste reduction or project monitoring separately, with limited empirical integration of these dimensions into a unified performance framework (Rajabi et al., 2022; Metwally et al., 2024). In developing construction markets, this gap is more

pronounced because adoption is often partial, project-specific and constrained by limited skills, financial barriers, weak digital infrastructure and organisational resistance (Pittri et al., 2025; Siddiqui et al., 2023). Consequently, the sustainability value of digital construction management remains underexplored, particularly regarding how technological practices translate into measurable building performance outcomes.

This study aims to examine the influence of technology-driven construction management practices on sustainable building performance. Its contribution lies in linking digital construction management with key sustainability outcomes, particularly cost efficiency, construction waste reduction, and project control and monitoring performance. The study offers theoretical value by extending the technology adoption and socio-technical systems perspectives, which argue that performance improvements emerge from interactions among technological capability, organisational processes, and human decision-making (Rame et al., 2024; Islam et al., 2025). In practice, the study provides evidence to guide contractors, consultants, clients, and policymakers in strategically adopting digital management systems to enhance the sustainable delivery of buildings.

The remainder of this paper is structured into four sections: a literature review establishing the theoretical and empirical foundations; a methodology outlining the research design; findings and discussion of the results; study implications for policy, research, and practice; and, finally, conclusions.

## LITERATURE REVIEW

### Concept of Sustainable Building Performance

Sustainable building performance has progressively shifted from a predominantly energy-centred perspective to a comprehensive, systems-based construct that integrates environmental stewardship, economic efficiency, and social value creation (Firoozi *et al.*, 2025). Early sustainability discourse in the built environment focused largely on reducing operational energy consumption through improved insulation, efficient mechanical systems, and the integration of renewable energy. However, contemporary scholarship recognises that sustainable performance must be assessed across the entire building life cycle, from material extraction and construction processes to operation, maintenance, and end-of-life management (Firoozi, Firoozi, et al., 2025). This broader framing reflects the growing awareness that environmental impacts are embedded not only in building operation but also in embodied carbon, construction waste generation, procurement decisions, and management practices.

Current definitions of sustainable building performance therefore emphasise life-cycle efficiency, resource optimisation, greenhouse gas mitigation, occupant health and comfort, and long-term asset resilience (Olabi *et al.*, 2024). Life cycle assessment methodologies demonstrate that embodied emissions in materials such as concrete and steel significantly contribute to total carbon footprints, underscoring the need for management interventions during planning and procurement stages. In parallel, resource efficiency is measured through indicators such as material utilisation rates, water consumption intensity, and waste diversion ratios. Social dimensions are increasingly incorporated through indoor environmental quality metrics, thermal comfort indices, and occupant wellbeing assessments, which are recognised as essential to productivity and public health outcomes (Horr *et al.*, 2016).

Within construction management research, sustainable building performance is operationalised through quantifiable project indicators (Rajabi *et al.*, 2022). These include cost efficiency, schedule reliability, reduced rework, minimised material losses, and enhanced operational performance. The link between management systems and sustainability outcomes is critical, as inefficient coordination, poor documentation, and inadequate monitoring often lead to cost overruns, excessive waste, and compromised environmental performance. Empirical evidence suggests that projects with structured performance measurement systems and integrated data platforms demonstrate improved compliance with sustainability targets. Thus, sustainability performance is not solely a function of green design features but also of managerial competence, process integration, and technological capability (Asiedu *et al.*, 2025).

The integration of sustainability principles into construction management aligns strongly with global policy frameworks, particularly the United Nations Sustainable Development Goals. SDG 9 promotes resilient

infrastructure and innovation; SDG 11 advocates sustainable cities and communities; SDG 12 emphasises responsible consumption and production; and SDG 13 calls for urgent climate action. Construction management practices influence each of these goals through procurement strategies, resource allocation decisions, waste management planning, and emission control mechanisms (Enobie *et al.*, 2024). Studies indicate that managerial practices, rather than design intent alone, largely determine whether sustainability objectives are realised during construction execution (Dosumu and Aigbavboa, 2018). In many cases, well-designed sustainable projects fail to achieve anticipated performance outcomes due to weak implementation structures and inadequate monitoring systems.

Consequently, the assessment of sustainable building performance must extend beyond static design evaluation tools to incorporate dynamic management and governance mechanisms embedded within project processes (Metwally *et al.*, 2024). Digital governance systems, performance dashboards, and integrated monitoring platforms provide real-time feedback on environmental and economic indicators, enabling corrective interventions during project delivery. The literature increasingly underscores the importance of aligning technological innovation with management capability to achieve measurable sustainability gains (Hamdouna and Khmelyarchuk, 2025). Sustainable building performance should therefore be conceptualised as an outcome of coordinated technological, managerial, and organisational systems rather than as an isolated design attribute.

In sum, sustainable building performance is a multidimensional construct shaped by life cycle thinking, performance measurement, and management effectiveness. Understanding its determinants requires a holistic examination of how construction management practices, particularly technology-driven systems, influence cost efficiency, waste reduction, and project control outcomes. This expanded perspective provides the theoretical foundation for evaluating the role of technology-driven construction management practices in enhancing sustainable building performance.

### **Technology-Driven Construction Management Practices**

Technology-driven construction management is the systematic integration of digital technologies and data-driven systems into planning, coordination, monitoring, and decision-making across the entire construction project lifecycle (Rinchen *et al.*, 2024). Unlike traditional management approaches that rely heavily on manual documentation, fragmented communication, and reactive control mechanisms, technology-driven systems enable real-time data capture, predictive analytics, and collaborative information sharing. This transformation enhances managerial efficiency and strengthens performance accountability in increasingly complex building projects. Core technologies underpinning this transformation include Building Information Modelling, Internet of Things sensors, artificial intelligence applications, cloud-based project management platforms, uncrewed aerial vehicles, and advanced data analytics systems (Naji *et al.*, 2024).

Building Information Modelling functions as a centralised digital repository that integrates architectural, structural, mechanical, cost, and scheduling data into a unified virtual environment. Through clash detection, 4D scheduling, and 5D cost modelling, BIM improves coordination accuracy and reduces rework. Internet of Things technologies complement BIM by embedding sensors within construction sites and built assets to capture real-time information on temperature, humidity, material movement, equipment performance, and energy consumption (Marfo *et al.*, 2025). These data streams facilitate continuous monitoring and proactive decision-making. Artificial intelligence and machine learning algorithms further enhance project control by analysing historical and live data to predict schedule delays, cost overruns, and safety risks. Cloud-based systems and mobile applications improve information accessibility and stakeholder collaboration, ensuring that decision-makers operate with synchronised, up-to-date project data.

The transition toward digitalised construction management reflects the broader technological evolution associated with Industry 4.0 and the emerging Industry 5.0 paradigm. Industry 4.0 emphasises automation, cyber-physical systems, data connectivity, and digital integration across value chains (Islam *et al.*, 2025). In the construction context, this involves digitised workflows, smart equipment, and interconnected project platforms. Industry 5.0 builds on this foundation by emphasising human-centred innovation, resilience, and the optimisation of sustainability. Rather than focusing solely on automation efficiency, Industry 5.0 promotes

alignment among technological systems, human well-being, environmental responsibility, and ethical governance (Rame *et al.*, 2024). Consequently, technology-driven construction management is not merely a productivity-enhancement strategy but a mechanism for achieving sustainable and resilient built-environment outcomes.

Empirical studies indicate that digital construction platforms significantly improve transparency, information flow, and stakeholder coordination. Integrated systems reduce information asymmetry between designers, contractors, and clients, thereby minimising disputes and variation orders (Ivić and Cerić, 2024). Real-time dashboards enable managers to monitor schedule progress, financial performance, and environmental indicators simultaneously, strengthening proactive control mechanisms. Furthermore, predictive analytics support evidence-based decision-making, enhancing cost reliability and resource optimisation. By reducing duplication, communication delays, and manual errors, technology-driven management practices improve efficiency and reduce material waste (Razib *et al.*, 2025).

Despite these documented benefits, adoption levels remain uneven across regions of the world. Advanced economies demonstrate higher levels of BIM maturity, integrated project delivery systems, and digital governance frameworks. In contrast, many developing economies face structural barriers, including high initial investment costs, limited digital infrastructure, inadequate technical skills, and organisational resistance to change (Rinchen *et al.*, 2024b). Small and medium-sized construction firms, in particular, face financial and training constraints that slow the diffusion of digital technologies. Consequently, while technology-driven construction management offers substantial potential to enhance project performance and sustainability outcomes, its realisation depends on contextual readiness, policy support, and organisational capability. This variability underscores the need for empirical investigation into how adoption levels influence sustainable building performance within specific contexts.

### **Adoption of Technology-Driven Practices in Building Projects**

The degree of adoption of digital construction management practices remains markedly uneven across global contexts, reflecting disparities in technological infrastructure, regulatory frameworks, organisational capacity, and economic readiness (Pittri *et al.*, 2025). Advanced economies such as those in Western Europe, North America, and parts of East Asia report substantial integration of Building Information Modelling, digital twins, cloud-based collaboration platforms, and integrated project delivery systems (Torres *et al.*, 2025). In these settings, digital workflows are often institutionalised through national BIM mandates, standardised data protocols, and industry-wide digital transformation strategies. Such environments foster greater interoperability, lifecycle data integration, and performance monitoring, enabling construction firms to leverage digital tools for cost control, sustainability assessment, and risk mitigation.

By contrast, many developing countries demonstrate partial, fragmented, or project-specific adoption patterns. Digital implementation is often limited to isolated applications rather than to integrated systems embedded throughout the project lifecycle (Rinchen *et al.*, 2024). For instance, BIM may be used primarily for visualisation or presentation purposes without full integration into cost modelling, procurement coordination, or facility management systems. Similarly, project management software may support scheduling and documentation but lacks advanced analytics or real-time performance dashboards (Radman *et al.*, 2025). This fragmented adoption constrains the transformative potential of digital construction management and limits its capacity to deliver measurable sustainability outcomes.

Empirical research in sub-Saharan Africa indicates a growing awareness of digital technologies among construction professionals; however, practical utilisation remains constrained (Pittri, Godawatte, Atibila, *et al.*, 2025). In many cases, firms rely predominantly on 2D modelling systems, spreadsheet-based cost estimation, and basic scheduling software. Advanced tools such as IoT-enabled monitoring, digital twins, and predictive analytics are seldom deployed at scale. The digital maturity of firms in the region often reflects broader systemic challenges, including inconsistent internet connectivity, limited access to high-performance computing resources, and insufficient investment in digital infrastructure (Rinchen *et al.*, 2024).

Several interrelated barriers explain this uneven adoption landscape. Financial constraints are a primary obstacle, particularly for small and medium-sized enterprises operating on narrow profit margins (Omowole *et al.*, 2024). Acquiring software licenses, upgrading hardware, training staff, and maintaining systems requires a substantial upfront capital investment. In contexts where construction markets are highly competitive and price-driven, firms may prioritise short-term cost minimisation over long-term technological investment.

Human capital limitations also play a critical role. The effective implementation of digital construction management systems requires specialised technical skills in BIM modelling, data analytics, sensor integration, and information management (Siddiqui *et al.*, 2023). In many developing economies, there is a shortage of professionals with advanced digital competencies, and formal training programmes may not adequately reflect emerging technological demands. Organisational resistance to change further compounds these challenges, as traditional management cultures may be reluctant to embrace process reengineering and digital transparency (Hubbart, 2023).

Understanding the extent of adoption is therefore critical to evaluating the influence of technology driven construction management practices on sustainable building performance. The maturity level of digital integration determines whether technology functions merely as a supplementary tool or as a transformative system that enhances cost efficiency, reduces waste, and strengthens project control. Projects with low digital maturity may experience only marginal improvements, whereas those with integrated, interoperable systems are more likely to achieve significant sustainability gains. Consequently, assessing adoption levels provides a necessary baseline for examining how technology-driven practices translate into measurable environmental and economic performance outcomes within building projects.

### **Cost Efficiency in Construction Projects**

Cost efficiency represents a central economic dimension of sustainable building performance, as it directly influences project viability, resource allocation, and long-term asset value (Signorini *et al.*, 2025). Within sustainability discourse, economic performance is not limited to minimising initial construction expenditure but extends to optimising lifecycle costs, reducing financial waste, and enhancing value for money. Inefficient cost management often results in material overconsumption, rework, delays, and contractual disputes, all of which undermine environmental and social sustainability objectives (Álvarez-Pozo *et al.*, 2024). Consequently, effective cost control mechanisms are integral to achieving balanced sustainability outcomes in construction projects.

Technology-driven construction management practices have significantly transformed traditional cost control approaches. Historically, cost estimation and monitoring relied heavily on manual calculations, fragmented documentation, and retrospective financial reporting (Ajayi *et al.*, 2024). Such systems were vulnerable to human error, information delays, and coordination gaps. The integration of digital tools such as Building Information Modelling, real-time analytics platforms, and cloud-based financial management systems has increased accuracy, transparency, and responsiveness in cost management processes.

BIM-based cost modelling, particularly 5D BIM applications, links geometric design data with cost databases, enabling automated quantity takeoffs and dynamic budget forecasting (Mia *et al.*, 2025). This integration reduces discrepancies between design intent and financial planning. Automated clash detection further enhances cost efficiency by identifying conflicts among structural, mechanical, and architectural components before construction commences, thereby preventing costly rework and site disruptions. Integrated data platforms also improve procurement accuracy by synchronising design specifications with supplier information, reducing the risk of overordering, duplication, and material waste (Mia *et al.*, 2025). Through these mechanisms, digital management systems contribute to more reliable cost estimation and tighter financial control throughout the project lifecycle.

Empirical studies indicate that digital project monitoring systems significantly reduce cost overruns by enabling early detection of deviations from planned budgets and schedules (Song *et al.*, 2025). Real-time dashboards provide project managers with continuous updates on expenditure patterns, resource utilisation, and productivity rates. When deviations are identified promptly, corrective measures can be implemented

before financial losses escalate. Enhanced stakeholder coordination facilitated by shared digital platforms further reduces miscommunication and contractual disputes, both of which are common drivers of cost escalation (Ezeh *et al.*, 2024).

Beyond construction phase efficiencies, automation and data analytics contribute to improved lifecycle cost performance. Predictive analytics tools analyse historical project data to forecast potential financial risks and inform proactive mitigation strategies (Gondia *et al.*, 2023). This capacity enhances financial predictability and supports strategic decision-making during planning and procurement. Moreover, digital documentation systems improve transparency and auditability, enhancing accountability and reducing the risk of fraudulent or inefficient financial practices.

The integration of technology-driven management practices, therefore, extends cost efficiency beyond short-term expenditure control to encompass long-term economic sustainability. By reducing rework, minimising variation orders, enhancing procurement precision, and strengthening financial forecasting, digital systems create more resilient and economically sustainable building projects. In this context, cost efficiency serves as both an outcome and an enabling mechanism of sustainable building performance, underscoring the importance of examining how technology-driven practices influence financial outcomes within construction management frameworks.

### **Construction Waste Reduction**

Construction waste has emerged as a critical sustainability concern within the global built environment, contributing significantly to landfill pressure, resource depletion, and greenhouse gas emissions (Bamisaye *et al.*, 2025). The construction sector is estimated to account for a substantial proportion of global solid waste generation and embodied carbon, largely due to inefficient material handling, overordering, design changes, and poor site coordination. In rapidly urbanising regions, particularly in developing economies, the problem is exacerbated by weak regulatory enforcement, limited digital integration, and fragmented project delivery systems. As the demand for infrastructure intensifies, improving construction waste management has become central to achieving climate mitigation targets and advancing circular economy principles within the sector (Anokye *et al.*, 2024).

Technology-driven construction management practices offer transformative pathways to reduce material waste throughout the project lifecycle. Digital modelling platforms such as Building Information Modelling enable precise quantity take-offs, clash detection, and scenario simulation before physical execution begins. Through 4D and 5D modelling, project teams can visualise construction sequences, anticipate material requirements, and optimise scheduling to minimise surplus procurement (Tanoli *et al.*, 2025). Empirical studies demonstrate that BIM-supported planning significantly reduces rework, overestimation, and material duplication, thereby lowering embodied carbon and cost overruns. Furthermore, digital twins and integrated project delivery systems facilitate enhanced coordination among stakeholders, reducing design-related discrepancies that often lead to on-site waste (Amer *et al.*, 2025).

Prefabrication and modular construction, enabled through digital coordination tools, further strengthen waste minimisation strategies (Parracho *et al.*, 2025). Offsite manufacturing environments operate under controlled conditions that improve material precision, standardisation, and quality assurance. Research indicates that prefabricated systems can reduce construction waste by up to 50 per cent compared to conventional onsite methods, primarily due to accurate cutting, reuse of offcuts, and streamlined logistics (Albaadani *et al.*, 2025). Digital integration enhances this process by aligning design specifications with manufacturing data, ensuring material optimisation at source. Such approaches not only reduce waste generation but also support circular resource flows by facilitating component reuse and disassembly planning.

In addition, Internet of Things-enabled tracking systems enhance real-time monitoring of material flows, inventory levels, and site conditions (Marfo *et al.*, 2025). Smart sensors and RFID technologies provide continuous data on material movement, storage conditions, and usage patterns, enabling proactive decision-making and reducing on-site damage or theft. Real-time analytics improve logistics coordination, ensuring just-in-time delivery and minimising prolonged storage, which often leads to deterioration. Studies confirm

that projects adopting advanced digital management systems report measurable reductions in material waste, improved inventory control, and enhanced circular resource utilisation (Olawade *et al.*, 2026)

Collectively, these technology-driven practices reposition waste management from a reactive disposal approach to a proactive, data-informed optimisation strategy. By integrating digital modelling, prefabrication coordination, and IoT-based monitoring, construction firms can substantially reduce environmental impacts while improving project efficiency. The evidence suggests that digital transformation is not merely a productivity tool but a strategic enabler of sustainable construction and resource circularity.

### **Project Control and Monitoring Performance**

Construction waste has emerged as a critical sustainability concern within the global built environment, contributing significantly to landfill pressure, natural resource depletion, and greenhouse gas emissions (Chen *et al.*, 2024). The construction sector accounts for a considerable share of global solid waste generation and embodied carbon, largely due to inefficient material handling, inaccurate quantity estimation, frequent design alterations, and fragmented site coordination. Material losses often occur at multiple stages, including procurement, transportation, storage, and installation, reflecting systemic inefficiencies embedded within traditional project delivery models (Donyavi *et al.*, 2023). In rapidly urbanising regions, particularly across developing economies, these challenges are intensified by weak regulatory enforcement, limited adoption of digital technologies, and informal construction practices. As infrastructure demand accelerates in response to population growth and urban expansion, effective construction waste management has become central to achieving climate mitigation targets, improving resource efficiency, and advancing circular economy principles within the built environment.

Technology-driven construction management practices offer transformative pathways to reduce material waste throughout the project lifecycle. Digital modelling platforms, such as Building Information Modelling, enable precise quantity takeoffs, clash detection, and scenario simulation before physical construction (Raza *et al.*, 2023). Through 4D scheduling and 5D cost integration, project teams can visualise construction sequences, anticipate material requirements, and optimise procurement strategies to minimise surplus ordering. Empirical evidence indicates that BIM-supported planning significantly reduces rework, material overestimation, and duplication of effort, thereby lowering embodied carbon emissions and project cost overrun. Beyond design coordination, digital twins and integrated project delivery systems enhance real-time collaboration among architects, engineers, contractors, and suppliers, reducing information silos that often lead to on-site discrepancies and waste (Moshood *et al.*, 2024). By embedding data-driven decision-making into early project phases, digital tools shift waste prevention upstream, maximising environmental and economic benefits.

Prefabrication and modular construction, facilitated by digital coordination platforms, further strengthen waste minimisation strategies (Adamolekun and Olaoye, 2025). Offsite manufacturing operates under controlled factory conditions that enhance precision cutting, standardisation, and quality control. Research demonstrates that prefabricated systems can reduce construction waste by up to 50 per cent compared with conventional onsite practices, primarily through improved dimensional accuracy, reuse of production offcuts, and optimised logistics management (Lu *et al.*, 2021). Digital integration aligns architectural design with manufacturing specifications, ensuring that materials are fabricated to meet exact performance requirements. This alignment reduces error margins and enhances supply chain transparency. Moreover, modular systems inherently support circular economy objectives by enabling component disassembly, reuse, and adaptability across building lifecycles, thereby extending material utility and reducing end-of-life disposal pressures.

In addition, Internet of Things-enabled tracking systems significantly enhance real-time monitoring of material flows, inventory control, and site performance (Marfo *et al.*, 2025). Smart sensors, radio frequency identification technologies, and cloud-based data platforms provide continuous information on material location, storage conditions, and usage rates. Such transparency enables proactive decision-making, minimises on-site damage, reduces theft, and prevents excessive stockpiling. Real-time analytics facilitate just-in-time delivery, optimise logistics coordination, and reduce the risk of material deterioration from prolonged exposure to environmental conditions. Studies confirm that projects integrating advanced digital management systems

report measurable reductions in material waste, improved operational efficiency, and enhanced circular resource utilisation (Seyyedi *et al.*, 2024).

Collectively, these technology-driven interventions reposition construction waste management from a reactive disposal-centred practice to a proactive, data-informed optimisation strategy. By integrating digital modelling, prefabrication coordination, and IoT-based monitoring, construction organisations can substantially reduce environmental impacts while improving cost efficiency and project performance. Digital transformation, therefore, functions not merely as a productivity enhancer but as a strategic enabler of sustainable construction and long-term resource circularity.

## METHODOLOGY

This study adopted a quantitative research methodology to investigate the influence of technology-driven construction management practices on sustainable building performance in Ghana. The methodology was designed to provide an objective, systematic, and statistically verifiable basis for examining how digital construction management tools contribute to cost efficiency, construction waste reduction, and project control performance. A quantitative approach was considered appropriate because the study focused on measurable variables and sought to test relationships among technology adoption and sustainability-related performance outcomes. This approach also enabled the conversion of professional perceptions into numerical data that could be analysed through descriptive and inferential statistical techniques.

The positivist research philosophy underpinned the study. Positivism assumes that social and organisational phenomena can be objectively measured and explained through empirical observation, structured measurement, and statistical analysis. This philosophical position was suitable for the present study because technology-driven construction management practices and sustainable building performance indicators can be operationalised into measurable constructs. The adoption of positivism therefore strengthened the objectivity, reliability, and replicability of the research process by reducing the influence of subjective interpretation and allowing conclusions to be drawn from observable data.

A descriptive and explanatory survey design was employed. The descriptive component was used to assess the current level of adoption of technology-driven construction management practices among built environment professionals. These practices included the use of digital project management platforms, Building Information Modelling, automated scheduling systems, cost management software, data analytics tools, and site monitoring technologies. The explanatory component examined the extent to which these technologies influence sustainable building performance outcomes. This design was appropriate because the study not only described existing industry practices but also tested the statistical relationship between the independent and dependent variables. The study further employed a cross-sectional survey design, in which data were collected from respondents at a single point in time. This was suitable for capturing professional views and analysing relationships among variables within a defined study context.

The study was conducted in Kumasi, Ghana, a major urban and construction hub with active public and private building projects. Kumasi was selected because of its growing infrastructure development, expanding construction activities, and concentration of built environment professionals. The target population comprised construction professionals directly involved in project planning, supervision, cost control, site coordination, monitoring, and performance evaluation. These included contractors, consultants, project managers, quantity surveyors, architects, engineers, and client representatives. Their technical knowledge and involvement in construction management decision-making made them appropriate respondents for the study.

The sample size for the study was hundred respondents. This sample was considered adequate for quantitative analysis and suitable for generating reliable statistical evidence. The study adopted a probability sampling procedure to improve representativeness and reduce sampling bias. Stratified random sampling was used where the professional categories were identifiable. This ensured that the different groups within the built environment profession were fairly represented. Within each stratum, respondents were randomly selected to ensure every eligible participant had an equal chance of inclusion. The use of a hundred respondents is also

consistent, where the Yamane formula was used to derive an approximate sample size of a hundred from a finite population of four hundred construction professionals.

Primary data were collected using a structured questionnaire. The questionnaire was designed to obtain standardised, comparable, and quantifiable responses from the selected respondents. It was divided into three main sections. The first section captured demographic and professional information, including professional role, years of experience, organisational type, and level of involvement in construction projects. The second section measured the extent of adoption of technology-driven construction management practices. The third section measured sustainable building performance indicators, focusing on cost efficiency, construction waste reduction, and project control performance. A five-point Likert scale was used to measure respondents' level of agreement with each item, ranging from strongly disagree to agree strongly.

The collected data were coded and analysed using SPSS. Descriptive statistics, including frequencies, percentages, mean scores, and standard deviations, were used to summarise respondents' characteristics and determine the level of technology adoption. Inferential statistical techniques, particularly correlation and regression analysis, were applied to examine the strength, direction, and significance of relationships between technology-driven construction management practices and sustainable building performance. Ethical considerations were strictly observed by ensuring voluntary participation, informed consent, anonymity, confidentiality, and academic use of the data only.

## RESULTS PRESENTATION

### Demographic Characteristics of Respondents

This section presents the demographic characteristics of the respondents who participated in the study. A total of one hundred (100) respondents took part in the survey. They were categorised by professional role, years of professional experience, type of organisation, organisational size, and level of involvement in construction management activities. Frequencies and percentages were used as descriptive statistical tools to summarise the respondents' demographic profile, as presented in Table 1.

Table 1: Demographic Characteristics of Respondents

Demographic Variable	Category	Frequency (N)	Percentage (%)
Professional role	Quantity Surveyor	21	21.0
	Consultant	14	14.0
	Contractor	26	26.0
	Project Manager	33	33.0
	Architect	4	4.0
	Engineer	2	2.0
	<b>Total</b>		<b>100</b>
Years of professional experience	Less than 5 years	30	30.0
	5 to 10 years	64	64.0
	11 to 15 years	2	2.0
	More than 20 years	4	4.0

	<b>Total</b>	<b>100</b>	<b>100.0</b>
<b>Type of organisation</b>	Public sector agency	38	38.0
	Contracting firm	32	32.0
	Consulting firm	16	16.0
	Client organisation	14	14.0
	<b>Total</b>	<b>100</b>	<b>100.0</b>
<b>Organisational size, number of employees</b>	Large enterprise, above 250 employees	6	6.0
	Medium enterprise, 51 to 250 employees	4	4.0
	Micro enterprise, 1 to 10 employees	22	22.0
	Small enterprise, 11 to 51 employees	68	68.0
	<b>Total</b>	<b>100</b>	<b>100.0</b>
<b>Level of involvement in construction management activities</b>	Managerial level, for example, project manager, contracts manager, site manager	41	41.0
	Operational level, for example, site supervisor, clerk of works, foreman	7	7.0
	Strategic level, for example, director, partner, principal, head of department	40	40.0
	Technical level, for example, architect, engineer, quantity surveyor, BIM/digital specialist	10	10.0
	Other	2	2.0
	<b>Total</b>	<b>100</b>	<b>100.0</b>

Source: Field data, 2026.

Table 1 presents the demographic characteristics of the 100 respondents who participated in the study. In terms of professional role, project managers formed the largest group, representing 33.0% of the sample. This was followed by contractors at 26.0%, quantity surveyors at 21.0%, consultants at 14.0%, architects at 4.0%, and engineers at 2.0%. This indicates that the study obtained responses from professionals directly involved in construction planning, cost management, design, supervision, and project delivery.

Regarding years of professional experience, most respondents had 5-10 years, accounting for 64.0% of the sample. Respondents with less than 5 years of experience represented 30.0%, while those with more than 20 years accounted for 4.0%. Only 2.0% had 11 to 15 years of experience. This suggests that the respondents had sufficient professional exposure to provide meaningful responses.

By organisational type, most respondents were from public sector agencies (38.0%), followed by contracting firms (32.0%), consulting firms (16.0%), and client organisations (14.0%). In relation to organisational size,

small enterprises with 11 to 51 employees dominated the sample at 68.0%, followed by micro enterprises at 22.0%, large enterprises at 6.0%, and medium enterprises at 4.0%.

Finally, most respondents were involved at the managerial level, representing 41.0%, closely followed by strategic-level respondents at 40.0%. Technical-level respondents accounted for 10.0%, operational-level respondents represented 7.0%, and other roles constituted 2.0%. Overall, the demographic profile shows that the study captured relevant views from experienced professionals across different organisational and management levels.

**Extent of Adoption of Technology-Driven Construction Management Practices in Building Projects**

Table 2 presents the quantitative results on the extent of adoption of technology-driven construction management practices in building projects. The findings show that technology-driven approaches assist construction organisations in building projects, with the highest mean score of 3.91, a standard deviation of 0.64, and a 1st rank. This indicates that respondents strongly recognised the usefulness of technology in supporting project delivery.

The second-ranked practice was that organisations integrate digital systems across planning, construction and lifecycle management stages, with a mean score of 3.66 and a standard deviation of 0.54. This suggests a moderate level of digital integration across project phases. Similarly, computer processes and client demand influence organisations’ adoption of digital construction management practices, with a mean score of 3.59 and a standard deviation of 0.64, ranking 3rd.

The results further show that organisations have sufficient financial capacity to invest in digital construction management practices, with a mean of 3.50 and a standard deviation of 0.50, ranking 4th. Policy support recorded a mean of 3.39, while knowledge-driven approaches recorded 3.08. The least-ranked variable was that project teams use organisation-based operational tools to implement technology-driven construction management practices, with a mean of 3.00 and a standard deviation of 0.54. Overall, the results indicate a moderate level of adoption.

Table 2. Statistics of Identifying the Extent of Adoption of Technology-Driven Construction Management Practices in Building Projects

Variables	N	Min	Max.	Mean	SD	Rank
Leadership and staff in our organisation are willing and ready to adopt digital construction management practices	100	2	5	4.73	.63	1 <sup>st</sup>
Our organisation has integrated digital systems across planning, construction, and lifecycle management stages	100	1	5	4.66	.84	2 <sup>nd</sup>
Competitive pressures and client demands influence our organisation’s adoption of digital construction management practices	100	1	5	3.91	.64	3 <sup>rd</sup>
Our organisation has sufficient financial capacity to invest in and sustain digital construction management practices.	100	1	5	3.90	.50	4 <sup>th</sup>
Existing regulatory and policy frameworks effectively support the adoption of digital construction management practices in our projects	100	1	5	3.84	.65	5 <sup>th</sup>
Digital systems used in our projects enable seamless data exchange among technology-driven stakeholders and	100	2	5	3.83	.68	6 <sup>th</sup>

across project phases						
Our organisation has adequate digital infrastructure to support technology-driven construction management for building projects.	100	1	5	3.08	.68	7 <sup>th</sup>
Project teams in our organisation possess the required digital skills to implement technology-driven construction management practices	100	1	5	3.05	.64	8 <sup>th</sup>

Source: Filed Data, 2026.

**The influence of technology-driven construction management practices on cost efficiency in construction projects.**

Table 3 presents the descriptive statistics on the influence of technology-driven construction management practices on cost efficiency in construction projects. The results show that real-time financial monitoring systems help reduce cost overruns, recording the highest mean score of 4.72 and standard deviation of 0.83, and were ranked 1st. This indicates that respondents strongly agreed that real-time cost tracking improves financial control in construction projects.

The second-ranked variable was that digital collaboration among stakeholders enhances transparency and reduces costly disputes, with a mean score of 4.68 and a standard deviation of 0.86. This suggests that collaborative digital platforms play a significant role in improving communication and reducing conflict-related costs. Predictive financial analytics improves the ability to anticipate and manage cost risks, ranked 3rd, with a mean score of 4.00 and a standard deviation of 0.53.

Furthermore, digital transparency and auditability systems improve financial accountability and cost efficiency, with a mean of 3.97 and a rank of 4th. In contrast, digital cost modelling, such as 5D BIM, ranked 5th with a mean of 3.95. The lowest-ranked variables were procurement data integration and technology-driven lifecycle cost optimisation, both with mean scores of 3.12. Overall, the results indicate that technology-driven practices positively influence cost efficiency, particularly through financial monitoring, collaboration and predictive cost control.

Table 3. Descriptive Statistics of determining the influence of technology-driven construction management practices on cost efficiency in construction projects

Variables	N	Mini.	Max.	Mean	SD	Rank
Real-time financial monitoring systems help reduce cost overruns in our construction projects	100	1	5	4.72	.83	1 <sup>st</sup>
Digital collaboration among stakeholders enhances transparency and reduces costly disputes	100	1	5	4.68	.86	2 <sup>nd</sup>
Predictive financial analytics improves our ability to anticipate and manage cost risks.	100	2	5	4.00	.53	3 <sup>rd</sup>
Digital transparency and auditability systems improve financial accountability and cost efficiency	100	2	5	3.97	.50	4 <sup>th</sup>
The use of digital cost modelling, such as 5D BIM, enhances cost accuracy and budget control in our projects	100	1	5	3.95	.59	5 <sup>th</sup>

Automated clash detection significantly reduces rework and associated cost increases	100	1	5	3.84	.69	6 <sup>th</sup>
Procurement data integration minimises material waste and unnecessary expenditure	100	1	4	3.12	.71	7 <sup>th</sup>
Technology-driven lifecycle cost optimisation improves long-term cost efficiency in our construction projects	100	1	5	3.12	.56	8 <sup>th</sup>

Source: Filed Data, 2026.

**The effect of technology-driven practices on construction waste reduction.**

Table 4 presents the quantitative results on the effect of technology-driven practices on construction waste reduction. The results indicate that just-in-time logistics management reduces waste caused by prolonged storage and overstocking, with the highest mean score of 4.62 and a standard deviation of 0.94, ranking 1st. This shows strong agreement among respondents that improved logistics planning contributes significantly to waste reduction.

The second-ranked variable was automated clash detection, which significantly reduces waste resulting from design conflicts, with a mean score of 4.55 and a standard deviation of 1.03. This suggests that digital design coordination helps prevent errors that may lead to rework and material wastage. 4D and 5D construction planning minimise rework and material duplication on site, ranking 3rd with a mean score of 3.93 and a standard deviation of 0.54.

Furthermore, IoT-based material tracking helps prevent material damage, theft, and deterioration, with a mean score of 3.91 and a rank of 4th, while prefabrication and modular integration reduce on-site material waste, with a mean score of 3.86 and a rank of 5th. The least-ranked variable was digital twin coordination improves lifecycle monitoring and reduces avoidable material waste, with a mean score of 3.13. Overall, the findings indicate that technology-driven practices positively support the reduction of construction waste.

Table 4. Statistics on the effect of technology-driven practices on construction waste reduction.

Variables	N	Min.	Max.	Mean	SD	Rank
Just-in-time logistics management reduces waste caused by prolonged storage and overstocking	100	1	5	4.62	.94	1 <sup>st</sup>
Automated clash detection significantly reduces waste resulting from design conflicts	100	1	5	4.55	1.03	2 <sup>nd</sup>
4D and 5D construction planning minimise rework and material duplication on site	100	1	5	3.93	.54	3 <sup>rd</sup>
IoT-based material tracking helps prevent material damage, theft, and deterioration	100	1	5	3.91	.62	4 <sup>th</sup>
Prefabrication and modular integration decrease on-site material waste in our projects	100	1	5	3.86	.70	5 <sup>th</sup>
Circular design and disassembly planning enhance material reuse and waste minimisation in our projects	100	1	4	3.79	.61	6 <sup>th</sup>
Digital quantity precision enabled by BIM reduces material	100	1	5	3.14	.62	7 <sup>th</sup>

overordering and waste in our projects						
Digital twin coordination improves lifecycle monitoring and reduces avoidable material waste	100	2	4	3.13	.44	8 <sup>th</sup>

Source: Filed Data, 2026.

**The influence of technology-driven practices on project control and monitoring performance.**

Table 5 presents the descriptive statistics on the influence of technology-driven practices on project control and monitoring performance. The results show that 5D cost resource alignment strengthens budget tracking and financial control during project execution, with the highest mean score of 4.68 and a standard deviation of 0.76, and it was ranked 1st. This indicates strong agreement among respondents that 5D-based cost alignment improves project financial monitoring.

The second-ranked variable was IoT-based material tracking, which enhances real-time supervision of material usage and site activities, with a mean score of 4.67 and a standard deviation of 0.79. This suggests that IoT applications are highly relevant for improving visibility and control over site operations. Controlled off-site manufacturing precision improves installation accuracy and performance monitoring, ranked 3rd, with a mean score of 3.99 and a standard deviation of 0.59.

Similarly, 4D scheduling integration enhances real-time monitoring of project timelines and sequencing, ranked 4th with a mean score of 3.97. At the same time, just-in-time logistics optimisation improves project control by aligning material delivery with site demand, ranked 5th with a mean score of 3.92. The least-ranked variable was that accurate digital quantity estimation improves project cost control and monitoring accuracy, with a mean score of 3.16. Overall, the results indicate that technology-driven practices positively influence project control and monitoring performance.

Table 5. Descriptive Statistics of determining the influence of technology-driven practices on project control and monitoring performance.

Variables	N	Mini.	Max.	Mean	SD	Rank
5D cost resource alignment strengthens budget tracking and financial control during project execution	100	2	5	4.68	.76	1 <sup>st</sup>
IoT-based material tracking enhances real-time supervision of material usage and site activities	100	2	5	4.67	.79	2 <sup>nd</sup>
Controlled off-site manufacturing precision improves installation accuracy and performance monitoring	100	2	5	3.99	.59	3 <sup>rd</sup>
4D scheduling integration enhances real-time monitoring of project timelines and sequencing	100	2	5	3.97	.46	4 <sup>th</sup>
Just-in-time logistics optimisation improves project control by aligning material delivery with site demand	100	1	5	3.92	.66	5 <sup>th</sup>
Digital twin collaboration improves coordination and reduces monitoring discrepancies across project teams	100	1	5	3.88	.59	6 <sup>th</sup>
Prefabrication and modular systems enhance quality control and reduce construction deviations	100	2	5	3.19	.60	7 <sup>th</sup>

Accurate digital quantity estimation improves project cost control and monitoring accuracy	100	1	5	3.16	.69	8 <sup>th</sup>
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Source: Filed Data, 2026.

## DISCUSSION OF RESULTS

The integration of the empirical findings with the reviewed literature demonstrates that technology-driven construction management practices contribute meaningfully to sustainable building performance through digital adoption readiness, cost efficiency, construction waste reduction, and project control. Overall, respondents recognised the relevance of digital technologies in construction management, as all measured variables recorded mean scores above the neutral midpoint of 3.00. This suggests that digital tools are increasingly viewed not as optional innovations but as essential management mechanisms for improving project delivery, cost control, coordination, and sustainability outcomes. This supports the argument that sustainable building performance is achieved not by green design alone but by the combined effects of technological capability, managerial competence, process integration, and effective monitoring systems (Firoozi et al., 2025; Rajabi et al., 2022; Asiedu et al., 2025). Thus, the findings confirm that sustainability in construction is a multidimensional outcome shaped by the interaction of organisational, technological, and managerial systems.

The first major issue relates to the adoption of technology-driven construction management practices. The highest-rated item was the willingness and readiness of leadership and staff to adopt digital construction practices, with a mean score of 4.73 and a standard deviation of 0.63. This was followed by the integration of digital systems across planning, construction, and lifecycle management stages, with a mean score of 4.66. These results indicate strong organisational and attitudinal readiness for digital transformation. In practical terms, construction professionals appear to understand the value of digital technologies in improving documentation, coordination, decision-making, and project performance. This finding supports Hubbart’s (2023) view that organisational culture and change readiness are important determinants of digital adoption. It also agrees with Siddiqui et al. (2023), who argue that digital transformation in construction depends not only on the availability of technology but also on leadership commitment, staff acceptance, and the restructuring of traditional project delivery processes.

However, the results reveal a significant implementation gap. Although leadership readiness and digital integration were highly rated, adequate digital infrastructure and required digital skills had the lowest mean scores, at 3.08 and 3.05, respectively. This suggests that construction organisations may be willing to adopt digital technologies but lack the technical, infrastructural, and human resource capacity to implement them effectively. This finding is consistent with Rinchen et al. (2024), Pittri et al. (2025), and Omowole et al. (2024), who observe that construction firms in developing economies often face barriers such as inadequate infrastructure, limited digital skills, poor internet connectivity, high software costs, and insufficient training. Therefore, digital adoption should not be understood merely as willingness to use technology. It also requires investment in infrastructure, skills development, financial support, and enabling policy frameworks.

The second theme concerns the influence of technology-driven construction management practices on cost efficiency. Respondents strongly agreed that real-time financial monitoring systems reduce cost overruns, recording the highest mean score of 4.72. Digital collaboration among stakeholders also ranked highly, with a mean score of 4.68. These findings show that cost efficiency is perceived as one of the most immediate benefits of digital construction management. Real-time financial systems allow project teams to track expenditure, detect deviations early, and take corrective action before overruns become severe. This supports Song et al. (2025), who argue that digital monitoring systems improve cost control by providing continuous updates on expenditure, productivity, and resource utilisation. Similarly, the strong rating for digital collaboration supports Ezeh et al. (2024), who found that shared digital platforms reduce miscommunication, contractual disputes, and information delays, which often contribute to cost escalation.

The results also show that predictive financial analytics, digital transparency, auditability systems, 5D BIM cost modelling, and automated clash detection contribute to cost efficiency. These findings align with Mia et al. (2025), who explain that BIM-based cost modelling links design geometry with cost databases to support automated quantity take-offs and dynamic budget forecasting. They also support Gondia et al. (2023), who maintain that predictive analytics improves anticipation of financial risk through historical data and trend analysis. However, the relatively low scores for procurement data integration and lifecycle cost optimisation, both at 3.12, indicate that digital technologies are still being applied mainly for short-term project cost control rather than whole-life asset management. This contrasts with Signorini et al. (2025) and Álvarez-Pozo et al. (2024), who emphasise that sustainable cost efficiency must include operational, maintenance, and end-of-life costs.

The third area of discussion relates to construction waste reduction. Just-in-time logistics management ranked highest, with a mean score of 4.62, followed by automated clash detection at 4.55. These findings suggest that respondents strongly associate digital technologies with improved material control, reduced overstocking, fewer design conflicts, and lower rework. This aligns with Bamisaye et al. (2025) and Anokye et al. (2024), who identify construction waste as a major sustainability challenge stemming from poor site coordination, material overordering, inefficient handling, and design changes. The strong rating for just-in-time logistics supports Marfo et al. (2025), who argue that IoT-enabled tracking and real-time analytics improve material flow, inventory management, and delivery coordination.

The rating for automated clash detection further confirms the role of BIM-enabled systems in waste reduction. Tanoli et al. (2025) and Amer et al. (2025) argue that 4D and 5D modelling allow project teams to visualise construction sequences, anticipate material needs, identify design conflicts, and reduce rework before physical construction begins. However, the lower scores for BIM-enabled quantity precision and digital twin coordination, with means of 3.14 and 3.13, suggest that advanced digital applications remain weakly embedded. This indicates a gap between basic operational technologies and more sophisticated lifecycle-oriented systems.

The fourth theme concerns project control and performance monitoring. The results show that 5D cost-resource alignment ranked highest, with a mean score of 4.68, followed by IoT-based material tracking at 4.67. These results demonstrate that respondents associate digital construction management with improved budget tracking, real-time supervision, and site accountability. This supports Rinchen et al. (2024), Naji et al. (2024), and Razib et al. (2025), who argue that digital dashboards, IoT systems, cost-resource modelling, and collaborative platforms enhance project visibility and proactive control. The findings also show that off-site manufacturing precision, 4D scheduling, just-in-time logistics, and digital twin collaboration improve sequencing, quality assurance, and monitoring accuracy.

In conclusion, the findings largely confirm the literature that technology-driven construction management improves sustainable building performance through cost efficiency, waste reduction, and project control. However, the benefits are stronger in operational areas such as monitoring, collaboration, logistics, and cost tracking than in strategic areas such as lifecycle costing, digital twins, procurement integration, and advanced BIM use. The study therefore indicates that the construction sector is transitioning toward digital management but has not yet reached full digital maturity. To maximise sustainability benefits, construction firms should invest in digital infrastructure, BIM training, data analytics skills, procurement integration, lifecycle cost management, and interoperable digital systems. This transition will enable digital construction management to function not only as a project efficiency tool but also as a strategic pathway for achieving sustainable building performance.

### **Study Implications For Research, Policy And Practice**

The findings of this study have important implications for research, policy, and practice in advancing technology-driven construction management to improve sustainable building performance. For research, the study provides a useful empirical basis for extending knowledge on how digital construction management practices influence cost efficiency, waste reduction, and project control. Future studies should move beyond general technology adoption and examine the specific performance contribution of individual tools such as 5D

BIM, digital twins, IoT-based material tracking, predictive analytics, and cloud-based project monitoring systems. Researchers should also consider longitudinal studies that measure the actual performance of digitally managed projects over time rather than relying only on professional perceptions. This would help establish clearer causal relationships between digital adoption and sustainable building outcomes. Further research should also compare public and private construction projects, large and small firms, and different geographical contexts to determine how organisational capacity, digital skills, and infrastructure readiness shape technology adoption.

For policy, the study highlights the need for stronger institutional support to accelerate digital transformation in the construction sector. Policymakers should develop clear national or sectoral guidelines that encourage the use of digital construction management systems in building projects. This may include BIM adoption standards, digital procurement protocols, project data management requirements, and sustainability reporting frameworks. Since the findings show gaps in digital infrastructure and skills, government agencies, professional bodies, and educational institutions should collaborate to provide training programmes, certification schemes, and incentives for firms investing in digital tools. Public procurement policies should also reward contractors and consultants who demonstrate capacity in digital cost control, waste minimisation, and project monitoring. Such policies would shift digital construction from an optional practice to a structured requirement for sustainable project delivery.

For practice, construction firms should treat digital management as a strategic investment rather than a supplementary project tool. Contractors, consultants, project managers, and clients should prioritise real-time financial monitoring, digital collaboration platforms, just-in-time logistics, automated clash detection, and IoT-based material tracking, as these practices have been shown to improve cost control, reduce waste, and enhance site supervision. Firms should also invest in staff training to close the gap between willingness to adopt technology and the capacity to implement it. Practical adoption should begin with affordable, scalable tools, then progress to advanced systems such as digital twins and lifecycle cost optimisation. Ultimately, the study implies that sustainable building performance depends not only on green design intentions but also on disciplined digital management, skilled personnel, integrated data systems, and continuous performance monitoring throughout the project lifecycle.

## CONCLUSION

This study concludes that technology-driven construction management practices play a significant role in enhancing sustainable building performance in Ghana's construction industry. The findings demonstrate that digital tools such as real-time financial monitoring systems, digital collaboration platforms, 5D cost modelling, automated clash detection, IoT-based material tracking, just-in-time logistics, and 4D scheduling contribute positively to cost efficiency, construction waste reduction, and project control. The results further show that professionals are increasingly willing to adopt digital construction practices, particularly where such tools improve transparency, financial accountability, site supervision, and decision-making.

However, the study also reveals that inadequate digital infrastructure, limited technical skills, weak lifecycle cost optimisation, and low application of advanced systems such as digital twins constrain the full sustainability benefits of digital construction management. This suggests that Ghana's construction sector is progressing toward digital transformation but has not yet achieved full digital maturity. Therefore, sustainable building performance cannot depend only on green design intentions; it requires integrated digital systems, skilled professionals, supportive policies, and continuous performance monitoring throughout the project lifecycle.

Overall, the study contributes to construction management knowledge by establishing that digitalisation is not merely an operational efficiency tool but a strategic pathway for achieving cost-effective, resource-efficient, and sustainably managed building projects.

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