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IMPACT OF CONSTRUCTION MANAGEMENT TECHNIQUES ON PROJECT PERFORMANCE IN GOMBE METROPOLIS, NIGERIA

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Abstract
The Nigerian construction industry is vital for economic growth but frequently suffers from cost overruns, delays, and quality issues. This study evaluates the impact of construction management techniques on project performance in Gombe Metropolis, Nigeria. A quantitative descriptive survey design was employed, collecting data from 232 built-environment professionals (engineers, architects, quantity surveyors, and builders) using structured questionnaires. The findings reveal a heavy reliance on traditional techniques, with Bar Charts (Gantt Charts) and the Critical Path Method (CPM) being the most prevalent (means: 4.17 and 4.04, respectively). Modern integrated approaches like Building Information Modeling (BIM) and Just-In-Time (JIT) are utilized only at moderate levels (means: 2.59 and 3.15). Project performance across cost, time, quality, and safety indicators was consistently moderate, with cost performance showing the highest variability (Mean = 3.33, SD = 0.92). Regression analysis established a statistically significant positive relationship between management techniques and project performance ($F = 24.418$, $p < .001$), with these techniques accounting for approximately 33% of the variance ($R^2 = 0.330$) in performance outcomes. The study concludes that while traditional methods enable baseline coordination, they are inadequate for optimized project delivery. It recommends that firms and regulatory bodies accelerate the adoption of BIM and Lean Construction through capacity building and that stakeholders adopt a holistic risk-management framework to address the external variables influencing the remaining 67% of performance variance.

Keywords: Construction Management, Project Performance, Critical Path Method (CPM), Building Information Modeling (BIM), Gombe Metropolis, Nigeria.

Introduction
Globally, the construction industry is shifting towards digitalization, integrating tools like Building Information Modeling (BIM) and Artificial Intelligence to reduce inefficiencies (Najafzadeh & Yeganeh, 2025). In emerging economies like Nigeria, this transition is critical for meeting development targets but is hindered by systemic barriers, including skill gaps and political instability (Sadri, 2025). The Nigerian industry faces unique challenges, with federal projects experiencing mean cost overruns of approximately 31.36% (Aligamhe *et al.,* 2024, cited in Yidi *et al*., 2025). At the regional level in Gombe State, constraints such as high interest rates, limited funding, and corruption (accounting for over 21% of cost variance) further diminish project outcomes (Oraegbune & Chom, 2022; Yidi *et al.,* 2025).

While the need for improved project management is evident, several literature gaps exist. There is a lack of comprehensive studies examining the specific factors and effectiveness of management techniques like CPM and Earned Value Management (EVM) within the Nigerian context, particularly in regions like Gombe State. Furthermore, existing literature often overlooks the socio-economic implications of project failures on local communities. This paper addresses these gaps by evaluating the impact of construction management techniques on project performance in Gombe Metropolis. The specific research questions were: (i) What are the construction management techniques used? (ii) What is the level of project performance? and (iii) What is the impact of these techniques on performance?

LITERATURE REVIEW

Construction Management Techniques

Construction management techniques encompass the systematic methods and tools employed to plan, coordinate, and control construction projects from inception to completion. The common project management techniques include Bar Charts, Line of Balance (LOB), Critical Path Method (CPM), Resource Planning, Program Evaluation and Review Techniques (PERT), and Precedence network methods (Bala *et al.*, 2018; Ekundayo *et al.*, 2013; Idoro, 2016; Inuwa *et al.*, 2014). The Critical Path Method (CPM) was developed in 1960 by the DuPont Corporation to facilitate maintenance work programming during chemical plant shutdowns (Ray, Craven, Wallace, & Roberts, 2019). CPM calculates the minimum completion time for a project, along with possible start and finish times for project activities, and was originally designed for computer-aided planning, offering real-time updates on duration or cost changes (Umoh, 2016).

Resource planning focuses on optimizing available resources, including human labor, machinery, tools, materials, and equipment, all of which impact a contractor's profit level (Simon, 2018). Handigund and Bhavikatti (2019) note that Bar charts, first developed by Henry Gantt, are easily understood and suitable for strict operational sequencing, permitting a high degree of control. Program Evaluation and Review Technique (PERT), developed by the US Navy in 1960, uses a three-point time estimate that considers uncertainties in activity durations, unlike the deterministic CPM model (Sackey & Kim, 2019). Aribisala, Otenaike, Balogun, and Ofusori (2017) observed that PERT assists project managers in identifying bottlenecks and overruns before they occur, enabling timely corrective actions.

Critical Path Method (CPM)

The Critical Path Method (CPM) is an analytical scheduling technique used to identify the sequence of crucial tasks determining a project's minimum duration. In Nigeria, CPM is widely recognized as essential for managing complex building projects where scheduling is vital for meeting deadlines and establishing task relationships (RSIS International, 2026). Research indicates that applying CPM can lead to significant efficiency gains; a study of a Nigerian building firm demonstrated that CPM reduced an initial project completion estimate from 45 weeks to 31 weeks by highlighting critical tasks and allowing better resource allocation (RSIS International, 2026). Beyond time reduction, CPM serves as a foundational tool for proactive decision-making and cost control. By breaking large projects into smaller, manageable activities, project managers can minimize labor costs and increase overall organizational productivity (RSIS International, 2026).

Program Evaluation and Review Technique (PERT)

Program Evaluation and Review Technique (PERT) is a statistical management tool designed to analyze and represent project tasks, specifically focusing on time variability. In the Nigerian construction industry, particularly within road construction, PERT is employed to achieve specified objectives within strict time and budget limits by optimizing resource use (Kehinde *et al.*, 2026). Unlike CPM, which often assumes fixed task durations, PERT accounts for uncertainties, identifying the minimum time needed for total project completion while visualizing interrelations between major events (Kehinde et al., 2026). The application of PERT in public projects is critical for effective planning and control, allowing project management teams to resolve conflicts between scope, cost, and quality by making necessary tradeoffs at project onset (Kehinde *et al.*, 2026).

Building Information Modeling (BIM)

Building Information Modeling (BIM) represents a digital shift in construction management, utilizing 3D, 4D (scheduling), and 5D (cost) models to enhance supervision and conflict resolution. In Nigeria, BIM has shown high impact on project programming and reduction of errors and omissions, which

are frequent causes of building collapse and project inefficiencies (Oraegbune *et al.*, 2022). Although awareness is growing, adoption remains relatively low at approximately 22.8%, with most practices limited to architectural modeling rather than fully integrated engineering processes (Oraegbune *et al.*, 2022). Literature suggests that for BIM to be effective in Nigeria, there must be a shift from traditional fragmented processes to a team-oriented approach where inputs from all professionals are captured in a single model (Oraegbune *et al.,* 2022).

Just-In-Time (JIT) and Lean Construction

Just-In-Time (JIT) is a management philosophy focused on delivering materials and resources exactly when needed, minimizing onsite storage costs and waste. In Nigerian urban centers, JIT-driven cost savings have reached up to 20% in large-scale projects by reducing over-ordering and risks of material damage or obsolescence (ResearchGate, 2026). This technique relies heavily on supplier collaboration and real-time monitoring tools, such as RFID or GPS tracking, to ensure seamless material flow and workforce management (Oraegbune *et al.*, 2022). JIT is frequently integrated with Lean Construction, a broader practice aimed at maximizing value while minimizing waste across the project lifecycle. In Nigeria, lean techniques like the Last Planner® System (LPS) and the 5S process are gaining traction to improve workflow and site organization (Oraegbune *et al.*, 2022).

Project Performance

Construction project performance is a multidimensional concept traditionally defined by the "Iron Triangle" of cost, time, and quality, but has recently evolved to incorporate safety, sustainability, and stakeholder satisfaction (Ibrahim, Zayed & Lafhaj, 2024). Measuring these metrics is essential for ensuring project viability and long-term value creation.

Cost Performance

Cost performance is a primary indicator of project success, focusing on whether a project is completed within its allocated budget (ResearchGate, 2026). Financial failure often stems from poor resource allocation, procurement delays, and rising material costs. Modern research utilizes Earned Value Analysis (EVA) and AI-driven tools to predict cost-saving strategies and manage narrowing profit margins (Ibrahim *et al.,* 2024). Beyond simple budget tracking, recent studies emphasize rework costs as a critical KPI, noting that correcting errors often consumes a significant portion of a project's total revenue (Indeed, 2025). Factors such as fraudulent practices and lack of clear evaluation standards are identified as major contributors to cost overruns in large-scale infrastructure projects (Fayomi, Onifade & Adeoye, 2023).

Time Performance

Time performance refers to the project's ability to meet predetermined deadlines and schedule milestones (Fayomi *et al.*, 2023). Inefficient time management is cited as a major concern because delays increase direct costs through prolonged labor and equipment usage while damaging a firm's reputation (Fayomi *et al.*, 2023). Current literature identifies downtime percentage caused by weather, equipment malfunction, or material shortages as a vital metric for proactive risk mitigation (Indeed, 2025). Scholars increasingly link schedule success to BIM adoption and integrated digital workflows, which allow teams to simulate stages before execution to avoid bottlenecks (Fayomi *et al.*, 2023).

Quality Performance

Quality in construction is defined as meeting customer needs and adhering to measurable technical specifications (Fayomi *et al.,* 2023). Performance in this area is typically tracked through inspection

pass rates and installation defect rates, which provide actionable feedback for improving team methods (Indeed, 2025). Quality performance is frequently compromised by human factors, engineering material deficiencies, and inadequate supervision (Wright & Lawlor-Wright, 2018). To address this, the industry is shifting toward quality assurance and risk mitigation frameworks utilizing real-time data tracking to detect compliance risks early (Wright *et al.,* 2018). Satisfactory quality now includes long-term lifecycle value and reduction of social and environmental impacts.

Safety Performance

Safety performance has transitioned from a regulatory requirement to a core KPI, with "incident rates" serving as the primary metric for evaluation (Indeed, 2025). Literature emphasizes that poor safety performance is often a byproduct of overloaded workforces and inadequate training programs (ResearchGate, 2025). Advancements show a trend toward proactive safety management using wearable technology and AI-powered incident analysis to prevent recurring issues (Olawale, 2024). Real-time hazard reporting via mobile applications allows for immediate intervention, moving the industry away from reliance on lagging indicators (Olawale, 2024).

Theoretical Framework: Theory of Constraints (TOC)

In explaining factors causing constraints affecting project performance in the construction industry, the Theory of Constraints (TOC) model by Goldratt (1999) was engaged. TOC explains five steps to identify and eliminate organizational constraints, providing a logical philosophy of continuous improvement by identifying factors limiting organizational goal attainment. The five steps involve: identification of system constraints, harnessing system constraints, subordinating strategic and tactical approaches to above decisions, elevating system constraints, and reapplying procedures for continuous improvement.

Watson (2007) detailed TOC's evolution across five eras: optimization production technology (1979-1984), the goal era (1984-1990), haystack syndrome (1990-1994), it's not locked era (1994-1997), and critical chain era (1997-2000). According to Stein (1997), TOC has grown in interest across accounting, marketing, logistics, construction project management, and industries desiring system change. Simsit *et al.* (2014) posited that constraints limit organizational performance, and identifying and eliminating constraints is TOC's focus due to its continuous search for improving organizational systems. Newbold (1998) suggested TOC applies to construction project management because its operations resemble manufacturing production processes where productivity is affected by various constraints, categorizing them under environmental, economic, legal, technical, and social factors.

Empirical Review

Carcaño (2018) researched time and cost control effects in construction projects in Mexico, evaluating Earned Schedule and Earned Value methods. Results showed construction firms need to emphasize project execution time management using modern engineering methods such as Earned Schedule. Olawale and Sun (2015) conducted a questionnaire survey among 250 top companies, followed by in-depth interviews with 15 experienced practitioners, developing 65 good practice recommendations for project control tasks. After two Delphi panel rounds, recommended project control tasks were identified as critical for improving project control practices.

Ahmadu and Ijigah (2014) examined construction planning effectiveness by small and medium construction firms, finding that planning exercises were mostly carried out by project managers who typically used bar chart techniques. Johnson and Babu (2018) studied time and cost performance in the UAE, identifying top causes of time overrun as design variations, unrealistic schedules, delays in government approvals, inaccurate time estimation, and client change orders. Top causes of cost

overrun included design variation, poor cost estimation, client decision-making delays, client financial constraints, and inappropriate procurement methods.
Idoro (2012) compared frequencies at which Nigerian contractors' project monitoring and control strategies influence project outcomes, surveying 86 contractors. Results revealed that three of eight monitoring and control strategies (site visits, site meetings, review of program of work) influenced project outcomes, while remaining strategies did not. Irefin (2013) evaluated project management effects on construction firm performance in Nigeria using Blackstone Construction firm as a case study, discovering that project quality management had a significant relationship with business success and technical success.

Methodology

A quantitative descriptive survey design was adopted. The target population comprised 530 built-environment professionals (architects, quantity surveyors, engineers, builders, consultants, contractors, and project managers) registered with their professional bodies in Gombe State. Using the Taro Yamane formula (e=0.05), a sample size of 232 respondents was derived. A purposive sampling technique was used to select participants based on their active involvement in construction projects. Data were collected using a structured questionnaire with Likert-scale items measuring management techniques (e.g., CPM, BIM, JIT) and project performance indicators (cost, time, quality, safety). Of 300 questionnaires administered, 247 were returned (82% response rate), and 232 were valid for analysis. Data were analyzed using descriptive statistics (means, standard deviations) and inferential statistics (linear regression) via SPSS.

Results

Management Techniques Used

Table 1 shows that traditional techniques dominate. Bar Charts and CPM have the highest adoption with High mean scores of 4.17 and 4.04, respectively. Modern techniques like BIM, PERT, and JIT/Lean Construction show only Moderate levels of use (means ranging from 2.59 to 3.15).

Table 1: Construction Management Techniques

Management Techniques Used	Mean	Std. Deviation	Ranking	Remarks
Bar Charts (Gantt Charts)	4.1700	1.29595	1	High
Critical Path Method (CPM)	4.0400	0.94491	2	High
Just-In-Time (JIT) / Lean Construction	3.1500	0.86093	3	Moderate
Resource Planning/Allocation	3.0800	.84687	4	Moderate
Program Evaluation & Review Technique (PERT)	2.7400	1.59849	5	Moderate
Building Information Modeling (BIM)	2.5850	1.28805	6	Moderate

Level of Project Performance

Table 2 indicates that all performance indicators are at a Moderate level. Cost performance is highest (Mean = 3.33) but most variable, while safety performance shows the lowest mean (2.99) and highest consensus (lowest SD).

Table 2: Level of Construction Project Performance in the Study Area

Level of Construction Project Performance	Mean	Std. Deviation	Ranking	Remarks
Cost Performance	3.3250	0.9157	1	Moderate

Time Performance	3.2700	0.7509	2	Moderate
Safety Performance	3.1100	0.6799	3	Moderate
Quality Performance	3.1000	0.8004	4	Moderate
Safety Performance	2.9850	0.5284	5	Moderate

Impact on Project Performance

Linear regression analysis (Table 3) shows a statistically significant positive relationship between management techniques and project performance ($F = 24.418$, $p < .001$). The R^2 value of 0.330 indicates that construction management techniques account for 33.0% of the variance in project performance.

Table 3: Regression Analysis Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	df	F	Sig.
1	.432[a]	.330	.306	.44286	1, 216	24.418	.000[b]

a. Dependent Variable: Construction Management Techniques
b. Independent Variable: Project Performance.

DISCUSSION

The results confirm that construction firms in Gombe heavily rely on traditional bar charts and CPM, aligning with prior Nigerian studies (Luthan *et al.,* 2021). The moderate adoption of BIM (mean 2.59) supports findings that its use in Nigeria is in its infancy due to high costs and a lack of skilled professionals (Owolabi *et al.,* 2024). This reliance on linear planning tools represents a technological plateau that limits the potential for optimized, data-driven project delivery. Regarding project performance, the moderate scores across all indicators suggest a stabilised mediocrity. The high variability in cost performance (SD = 0.92) reflects Nigeria's volatile economic landscape (Inuwa et al., 2014), while the consistent moderate score for safety (SD = 0.53) indicates a slowly maturing safety culture (Muhammad *et al.,* 2025). The core finding that management techniques account for 33% of performance variance is significant ($p < .001$) but not dominant. This aligns with Agyekum *et al.* (2022) but differs from studies reporting higher explanatory power, likely due to the strong influence of unmeasured external factors in Gombe, such as supply chain disruptions, inflation, and local corruption (Yidi *et al.,* 2025).

CONCLUSION AND RECOMMENDATIONS

The study concludes that while traditional construction management techniques (Bar Charts, CPM) provide a necessary baseline for project coordination, their dominance in Gombe Metropolis represents a barrier to achieving high-level project performance. The moderate and inconsistent adoption of modern techniques like BIM and JIT, alongside a stabilised mediocrity in cost, time, and quality outcomes, indicates that current practices are insufficient for optimized delivery. Critically, management techniques are a significant yet partial driver of success, accounting for only one-third of performance variance. Construction firms and regulators should implement a phased transition plan to integrate BIM and Lean Construction with existing tools, supported by subsidized digital infrastructure and mandatory continuous professional development (CPD) programs. The Gombe State government should incentivise the adoption of integrated performance monitoring systems that link real-time cost tracking with quality assurance to reduce budget variability. Investigate the specific external systemic factors (macroeconomic volatility, political interference) that constitute the remaining 67% of performance variance, using longitudinal data to develop predictive risk-management models.

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