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Influence of Sustainable Construction Practices on Labour Productivity in Building Projects in Abuja, Nigeria

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ABSTRACT

The relationship between sustainable construction and labour productivity is increasingly important in project delivery, yet the two concerns are often assessed separately in developing construction markets. This study examined the association between sustainable construction practices and perceived labour productivity in building projects in Abuja, Nigeria. Sustainable construction was operationalised through four measurable domains: environmental resource efficiency, sustainable site operations, workforce safety, and institutional and market support. A quantitative cross-sectional survey was conducted among registered builders, quantity surveyors, architects and civil engineers involved in building-project delivery. From an accessible population of 728 professionals, 258 respondents were proportionately allocated across the four professional strata, and 232 usable questionnaires were returned, representing an 89.9% response rate. Mean scores, ranking and simple linear regression were used for analysis. Improved site safety recorded the highest adoption (mean = 4.32), followed by waste reduction and management (mean = 4.18) and environmentally preferable materials (mean = 4.05). Poor site safety, inadequate training and unfavourable working conditions were the leading perceived productivity constraints. Sustainable construction practices were positively and significantly associated with labour productivity, $R = .432$, $R^2 = .187$, adjusted $R^2 = .183$, $F(1, 230) = 52.84$, $p < .001$. The model is interpreted as a gross predictive association rather than a causal effect because productivity was self-reported and project-level controls were unavailable. The findings support the integration of safety, training, waste control and worker welfare into production planning, while future research should verify the relationship using output-per-labour-hour records, broader occupational samples and multivariate or comparative designs.

Keywords: Abuja; building projects; construction labour; labour productivity; sustainable construction

INTRODUCTION

The buildings and construction sector supports employment, urbanisation, commerce and public service delivery, but it also consumes substantial energy and materials and generates considerable emissions and waste. The United Nations Environment Programme and Global Alliance for Buildings and Construction (UNEP & GlobalABC, 2026) estimate that the sector accounts for approximately 37% of global carbon dioxide emissions and almost half of global material extraction. Consequently, sustainability is no longer a peripheral design aspiration; it has become an important construction-management requirement covering material selection, resource efficiency, waste control, worker protection, project governance and life-cycle value. In Nigeria, this transition is especially important because the construction sector must respond simultaneously to infrastructure deficits, cost instability, workforce challenges and growing environmental pressures.

Sustainable construction refers to the planning, design, procurement, production, operation and eventual deconstruction of built assets in ways that balance environmental protection, economic viability and social well-being. To avoid treating the concept as an undifferentiated ideal, this study organised the observed practices into four measurable domains. Environmental resource efficiency covered material choice, energy use and waste management; sustainable site operations concerned site planning and resource control;

ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XV, Issue VIII, August 2026

workforce safety represented the social and occupational dimension; and institutional and market support covered government support and client demand. These domains connect the broad sustainability concept to decisions that can be observed and managed during project delivery. Isang (2023) notes that Nigerian sustainable-construction research has progressed from basic awareness towards implementation, policy and performance concerns. Yet adoption remains uneven, and unsustainable material, safety, energy and technology practices continue to weaken project delivery (Omopariola et al., 2022).

Labour productivity is the efficiency with which labour input is transformed into completed construction output. Direct indicators include installed quantity per labour-hour, labour cost per unit of work and output completed per worker; project records may also capture waiting time, rework and schedule performance. Where such records are incomplete or commercially sensitive, professional assessments of work rate, idle time, quality consistency, rework and workforce effectiveness provide a practicable but subjective alternative. Construction labour is sensitive to supervision, skills, motivation, fatigue, safety, material availability and workflow stability. Adebowale and Agumba (2023) identify training, rework, management style, competence and labour incentives among recurrent determinants in developing countries. Consequently, productivity improvement requires coordinated working conditions and reliable resource flow, not simply greater work intensity.

Sustainable construction may provide such a system. Waste minimisation can reduce obstruction and double handling; safe work arrangements can decrease incidents and interruptions; training can strengthen competence; and healthier work conditions can reduce fatigue and absenteeism. Nigerian evidence supports parts of this pathway. Onubi et al. (2021) found that green construction practices were related to health-and-safety performance, although economic performance affected how those benefits were realised. Earlier, Onubi et al. (2020) showed that client type could condition the relationship between particular green practices and safety outcomes. These findings support a sustainability-productivity relationship but also demonstrate that benefits depend on implementation quality and project context.

Abuja provides a relevant but bounded setting for examining this relationship. As Nigeria's Federal Capital Territory, it contains substantial public and private building activity and a concentration of contractors, consultants, regulatory agencies and professional practices. Project delivery nevertheless remains exposed to workforce shortages, weak safety systems, material disruptions and uneven enforcement. Nigerian studies have examined sustainability awareness, barriers, policy and safety outcomes (Babalola & Harinarain, 2024; Oladokun et al., 2021; Tunji-Olayeni et al., 2020), but limited empirical attention has been directed to the aggregate relationship between sustainable construction and labour productivity in Abuja. Evidence from this setting is therefore useful for locally situated decision-making, although it should not be interpreted as nationally representative without replication in other Nigerian construction markets.

Accordingly, this study examined the influence of sustainable construction practices on perceived labour productivity in building projects in Abuja. It pursued four objectives: (i) to assess the extent of sustainable construction-practice adoption; (ii) to identify the challenges affecting construction labour productivity; (iii) to evaluate sustainability-related factors associated with labour productivity; and (iv) to determine the predictive association between sustainable construction practices and labour productivity. The null hypothesis stated that sustainable construction practices have no significant association with labour productivity in building projects in Abuja.

LITERATURE REVIEW

Sustainable Construction Practices

The conceptual foundation of sustainable construction is commonly expressed through the environmental, economic and social dimensions of the triple bottom line (TBL). Elkington (1997) argues that organisational performance should be evaluated through interconnected outcomes for people, planet and prosperity rather than financial returns alone. Applied to construction, the environmental dimension concerns energy, materials and waste; the economic dimension concerns resource efficiency, productivity, durability and whole-life

ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XV, Issue VIII, August 2026

value; and the social dimension concerns safety, health, skills and welfare. For empirical clarity, the present study linked these principles to four observable domains: environmental resource efficiency, sustainable site operations, workforce safety, and institutional and market support. This operational boundary reduces conceptual ambiguity, although the aggregate regression estimates the combined association and does not isolate a separate causal effect for each domain.

Material selection and management represent a major sustainability pathway. Environmentally preferable, durable and locally appropriate materials can reduce transport impacts, waste and replacement demand. However, material sustainability does not automatically translate into productivity. Adebowale and Agumba (2025) demonstrate that bamboo and related sustainable materials can offer handling, safety and productivity benefits, but these advantages depend on standards, quality, supply reliability and workforce competence. Therefore, the productivity value of sustainable materials is conditional on constructability, procurement planning and training rather than the environmental label alone.

Construction waste prevention also connects sustainability to productivity. Waste represents not only discarded material but also the labour used in unnecessary transport, sorting, rehandling, correction and disposal. Lean-construction research shows that workflow reliability, coordinated planning and the elimination of non-value-adding activities can support resource efficiency (Babalola et al., 2019). In the Nigerian context, Omopariola et al. (2022) identify inadequate waste management and weak site practices as persistent sustainability problems. Thus, effective storage, accurate estimating, segregation, reuse and housekeeping can improve both environmental performance and productive labour time.

Occupational health, safety and worker welfare form the social core of sustainable construction. Unsafe sites generate injuries, work stoppages, investigations, absenteeism and reduced morale. Aka et al. (2023) show that the effectiveness of health-and-safety strategies in Nigeria depends on implementation, supervision and organisational commitment. Similarly, Onubi et al. (2021) establish that green practices and safety performance are related. From a productivity perspective, safety should therefore be viewed not merely as regulatory compliance but as a mechanism for preserving labour availability, concentration and workflow continuity.

Training and knowledge management are equally important. New materials, equipment and resource-efficient methods may initially reduce productivity when workers lack familiarity, but their performance can improve when adoption is supported by structured learning. Manoharan et al. (2024) report that work-based training improves construction labour knowledge, behaviour and productivity. This evidence indicates that sustainability innovations should be accompanied by task-specific instruction, coaching and performance feedback. Without workforce capability, technically sound practices may remain underused or may introduce errors and resistance.

Construction Labour Productivity

Construction labour productivity is influenced by interacting worker, management, project and external factors. Worker-level factors include skills, experience, health, fatigue and motivation; management factors include supervision, communication, planning and incentives; project factors include design complexity, rework, congestion and material flow; while external factors include weather, regulation and market instability. Adebowale and Agumba (2023) conclude that competence, training, rework and managerial arrangements are particularly influential in developing-country construction firms. Ozigbo et al. (2025) further show that Nigerian artisans face persistent skills, welfare and institutional constraints that limit their contribution to project delivery.

Productivity is frequently reduced by waiting rather than inadequate physical effort. Workers may remain idle because materials, tools, information, access or preceding work are unavailable. Poor site layouts increase movement; weak housekeeping creates obstruction; and defective work produces rework. These problems illustrate why labour productivity should be treated as a system outcome. Sustainable site management can address this system by improving logistics, material flow, safety, welfare and resource discipline. However,

ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XV, Issue VIII, August 2026

the benefits are unlikely to be uniform because firm capability, project complexity and institutional support affect implementation.

Empirical Relationship and Research Gap

Evidence from Nigeria shows growing awareness of sustainable construction but a persistent implementation gap. Tunji-Olayeni et al. (2020) found that practitioners recognised important drivers and practices, while Oladokun et al. (2021) reported that actual deployment depended on organisational and industry conditions. Babalola and Harinarain (2024) identified policy and institutional barriers, and Unegbu et al. (2025a) emphasised regulation, finance, technology and stakeholder collaboration as constraints. Conversely, Unegbu et al. (2025b) demonstrated that sustainable-practice relationships can be represented through an integrated structural model, indicating that implementation is shaped by several mutually reinforcing factors.

Studies connecting sustainability to operational outcomes provide supportive but incomplete evidence. Lawal et al. (2024) found a positive relationship between sustainable project-management practices and construction-company performance. Onubi et al. (2020, 2021) linked green practices with safety and economic outcomes, while Manoharan et al. (2024) linked structured work-based training with labour performance. Nevertheless, company performance and safety are not equivalent to labour productivity, and much Nigerian evidence is national or drawn from locations outside Abuja. Existing studies also frequently examine individual sustainability practices in isolation. This study addresses the contextual and relational gap by using a clearly bounded set of measurable practice domains and testing their aggregate association with perceived labour productivity in Abuja. Because the design is cross-sectional and does not include project-level controls, the test estimates predictive association rather than experimental or causal influence.

METHODOLOGY

Research Design and Study Area

The study adopted a quantitative cross-sectional survey design with descriptive and explanatory components. The descriptive component assessed sustainable-practice adoption, perceived productivity challenges and sustainability-related productivity factors, while the explanatory component tested whether the sustainable-practice composite predicted the labour-productivity composite. The design enabled standardised evidence to be collected from a relatively large professional population at a defined period (Creswell & Creswell, 2023). It supports statistical association and prediction but, without temporal ordering, objective productivity records and experimental control, does not establish causality.

The study was conducted in Abuja, Nigeria's Federal Capital Territory. Abuja was selected because continuing public and private investment in residential, commercial, institutional and infrastructure projects brings together government agencies, consultants, contractors and construction professionals. The geographic boundary made a focused examination feasible, but the market structure and regulatory concentration of the Federal Capital Territory may differ from those of other Nigerian regions; consequently, external validity is limited to comparable urban building-project contexts.

Population, Sample Size and Sampling

The study population comprised 728 registered builders, quantity surveyors, architects and civil engineers identified through accessible professional records for Abuja. These groups were included because they contribute production-management, cost and resource-control, design and material-selection, technical, and supervisory perspectives to building-project delivery. The sampling frame therefore represented registered built-environment professionals rather than every firm, project manager, site supervisor, tradesperson or construction worker in the Abuja industry. This distinction defines the population to which the survey estimates can reasonably be generalised.

ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XV, Issue VIII, August 2026

Table 1. Population and proportionate sample allocation

Professional group	Population	Proportionate sample
Builders	224	79
Quantity surveyors	195	69
Architects	119	42
Civil engineers	190	68
Total	**728**	**258**

The sample size was determined with Yamane's (1967) finite-population formula at a 5% level of precision. The resulting 258 cases were allocated proportionately across the four professional strata, thereby preserving the known structure of the accessible population and preventing larger groups from being underrepresented. Eligible participants were approached from the available professional lists within each stratum. This procedure provided broader coverage than an unstructured convenience sample, but incomplete professional lists and non-response may still have produced coverage or selection bias. The achieved 232 usable responses were therefore interpreted in relation to the defined registered-professional frame.

Instrument, Measurement and Data Collection

Data were collected through a structured questionnaire developed from the reviewed literature and aligned with the four research objectives. Sustainable construction was represented by seven observable practices arranged for interpretation under four domains: environmental resource efficiency (materials, energy and waste), sustainable site operations, workforce safety, and institutional and market support (government support and client demand). Labour-productivity items captured professional perceptions of work rate, idle time, quality consistency, rework, schedule performance and workforce effectiveness. Substantive items used a five-point Likert scale from 1 = strongly disagree to 5 = strongly agree. Multiple items broadened construct coverage, but the measures remained perceptual; installed quantities, labour-hours and unit labour costs were not obtained from project records. Content and face validity were supported through literature-derived indicators and expert assessment of item clarity, relevance and alignment. Separating the questionnaire into respondent, practice, challenge, factor and outcome sections improved conceptual organisation, while confidential and voluntary participation reduced pressure to provide favourable responses. The instrument was administered physically and electronically where necessary. Of the 258 questionnaires distributed, 232 were completed and retained, producing an 89.9% response rate. Nevertheless, common-source and social-desirability bias cannot be excluded because predictor and outcome measures were reported by the same professionals at one time.

Data Analysis

Frequencies and percentages described the respondents, while mean scores and ranks addressed the first three objectives. Mean scores were interpreted as follows: 1.00-1.80 = very low; 1.81-2.60 = low; 2.61-3.40 = moderate; 3.41-4.20 = high; and 4.21-5.00 = very high. Simple linear regression tested the null hypothesis at the .05 significance level, with sustainable construction practices as the predictor composite and perceived labour productivity as the outcome composite. Worker experience and skills, project size and type, technology, management quality, material availability and weather were not available as project-level covariates. The coefficient is therefore an unadjusted bivariate estimate that may include the influence of omitted productivity determinants. The model was specified as:

$$\mathrm{LP} = \beta_0 + \beta_1 \mathrm{SCP} + \varepsilon$$

ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XV, Issue VIII, August 2026

where LP represents perceived labour productivity, SCP represents the sustainable-construction-practice composite, β_0 is the intercept, β_1 is the regression coefficient and ε is the error term. The analysis reported R, R^2, adjusted R^2, F, standardised β, t and statistical significance. The model tests whether SCP predicts LP within the sample; it does not estimate a controlled causal effect or compare objectively measured high- and low-adoption projects.

RESULTS

Extent of Sustainable Construction Practice Adoption

Table 2 shows that improved site safety recorded the highest adoption (mean = 4.32), indicating a very high level. Waste reduction and management ranked second (mean = 4.18), followed by the use of environmentally preferable materials (mean = 4.05). Energy-efficient construction methods and sustainable site management were also rated highly. Government support was marginally high, whereas client demand recorded a moderate score. The pattern suggests that site-level practices with immediate operational value received stronger attention than externally driven practices.

Table 2. Extent of sustainable construction practice adoption

Rank	Sustainable construction practice	Mean	Interpretation
1	Improved site safety practices	4.32	Very high
2	Waste reduction and management	4.18	High
3	Use of environmentally preferable materials	4.05	High
4	Energy-efficient construction methods	3.97	High
5	Sustainable site management	3.86	High
6	Government support for sustainability	3.42	High
7	Client demand for sustainable construction	3.28	Moderate

Challenges Affecting Labour Productivity

Poor site safety conditions were the highest-ranked productivity challenge (mean = 4.41), followed by inadequate training and skills (mean = 4.27) and poor working environments (mean = 4.15), as presented in Table 3. Lack of worker motivation, poor supervision, material shortages and long working hours were also rated highly. These findings show that respondents understood labour productivity as a product of working conditions, competence, management and resource availability rather than physical effort alone.

Table 3. Challenges affecting construction labour productivity

Rank	Labour-productivity challenge	Mean	Interpretation
1	Poor site safety conditions	4.41	Very high
2	Inadequate training and skills	4.27	Very high
3	Poor working environment	4.15	High

ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XV, Issue VIII, August 2026

4	Lack of worker motivation	4.02	High
5	Poor supervision	3.94	High
6	Material shortages	3.81	High
7	Long working hours	3.68	High

Sustainability-Related Factors Influencing Labour Productivity

Improved site safety was the strongest sustainability-related productivity factor (mean = 4.45), while a healthy working environment ranked second (mean = 4.31). Training in sustainable practices ranked third (mean = 4.19), followed by efficient waste management (mean = 4.07). Sustainable materials, reduced work-related stress and improved teamwork were also rated highly. As shown in Table 4, the findings present a consistent human-centred pathway in which sustainability improves productivity through safety, health, competence and better workflow.

Table 4. Sustainability-related factors influencing labour productivity

Rank	Factor	Mean	Interpretation
1	Improved site safety	4.45	Very high
2	Healthy working environment	4.31	Very high
3	Training in sustainable practices	4.19	High
4	Efficient waste management	4.07	High
5	Use of sustainable materials	3.95	High
6	Reduced work-related stress	3.88	High
7	Improved teamwork	3.79	High

Influence of Sustainable Construction Practices on Labour Productivity

Table 5 indicates a positive, moderate and statistically significant bivariate association between sustainable construction practices and perceived labour productivity. The correlation was .432, and the model accounted for 18.7% of the observed variance in labour productivity ($R^2 = .187$; adjusted $R^2 = .183$). The regression was statistically significant, $F(1, 230) = 52.84$, $p < .001$, with a positive standardised coefficient ($\beta = .432$, $t = 7.27$, $p < .001$); the null hypothesis was therefore rejected. The result is meaningful for a single predictor, but it is not an adjusted effect. The unexplained variance, together with the absence of project-level controls, indicates that skills, supervision, project complexity, technology, materials and weather may also account for differences in productivity.

Table 5. Regression of labour productivity on sustainable construction practices

Statistic	Value	Interpretation
Cases (n)	232	Complete cases included

ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XV, Issue VIII, August 2026

Multiple correlation (R)	.432	Positive moderate relationship
Coefficient of determination (R^2)	.187	18.7% of variance explained
Adjusted R^2	.183	Adjusted model fit
F(1, 230)	52.84	Model statistically significant
Standardised coefficient (β)	.432	Positive predictor effect
t(230)	7.27	Coefficient statistically significant
Significance	$p < .001$	Null hypothesis rejected

DISCUSSION

The findings show that the four sustainable-construction domains were not equally evident in Abuja. Site safety, waste management and environmentally preferable materials were rated more highly than government support and client demand. This pattern suggests stronger adoption of practices whose operational value is visible within the project boundary than of measures dependent on external institutions or market demand. Tunji-Olayeni et al. (2020) similarly found that Nigerian practitioners recognised several sustainable practices but faced contextual implementation constraints, while Oladokun et al. (2021) show that deployment depends on organisational commitment and industry conditions. Client demand is particularly important because contractors may have little incentive to exceed minimum requirements when sustainability is absent from briefs, tenders and contract administration. The domain-based interpretation also clarifies that the aggregate score combines related but distinct environmental, operational, social and institutional mechanisms.

Safety occupied a distinctive position across the findings: it was the most adopted practice, the most severe productivity constraint when absent and the strongest sustainability-related productivity factor when improved. This consistency indicates that respondents viewed safety as the primary operational bridge between sustainability and labour productivity. The result supports Aka et al. (2023), whose Nigerian evidence emphasises effective implementation of site health-and-safety strategies. It also agrees with Onubi et al. (2021), who found a relationship between green practices and safety performance. The implication is that safety investments can produce both social value and economic benefit by reducing incidents, work stoppages, fatigue and lost labour time.

Training and the working environment also emerged as central productivity pathways. Inadequate skills were the second-highest productivity challenge, while sustainability training ranked among the strongest positive factors. Manoharan et al. (2024) similarly demonstrate that structured work-based training improves construction labour knowledge, behaviour and performance. This evidence is especially relevant when projects introduce unfamiliar sustainable materials or methods. A practice that is technically efficient may initially reduce output if workers do not understand its application. Training therefore mediates the movement from sustainability intention to operational performance by improving competence, acceptance and error control.

The high rating assigned to waste management confirms that environmental and productivity objectives can converge. Poor housekeeping and material waste increase movement, obstruction, rehandling and disposal effort. Effective prevention, protected storage, segregation and reuse can consequently improve workflow while reducing environmental burdens. This interpretation is consistent with the lean-construction synthesis by Babalola et al. (2019), which links waste reduction and workflow reliability. Nevertheless, waste strategies require planning and supervision. Segregation systems that are introduced without adequate space,

ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XV, Issue VIII, August 2026

responsibilities or collection arrangements may become additional site burdens rather than productivity mechanisms.

The positive regression result supports the study's central proposition at the level of statistical association. Sustainable construction practices accounted for 18.7% of variation in perceived labour productivity, a meaningful but incomplete contribution. This agrees with Lawal et al. (2024), who reported positive relationships between sustainable project-management practices and construction-company performance, and it is consistent with the TBL expectation that people-oriented and resource-efficient practices can reinforce economic outcomes. However, the estimate should not be read as proof that sustainability alone caused higher productivity. Respondents may rate both constructs favourably, and unmeasured differences in experience, project complexity, supervision, technology, payment, weather and material supply may partly explain the association. A controlled multivariate or longitudinal design is required to distinguish these alternative explanations.

The findings also reveal an institutional imbalance: internal site practices were rated more highly than government support and client demand. Babalola and Harinarain (2024) identify policy barriers as important constraints, while Unegbu et al. (2025a) emphasise regulatory, financial, technological and collaborative limitations. Sustainable productivity cannot therefore depend exclusively on voluntary contractor action. Clients should translate sustainability into measurable procurement requirements, and regulators should combine enforcement with capacity development. At the same time, additional documentation without practical monitoring may encourage symbolic compliance. A balanced system should link minimum standards and training to observable outcomes, including labour-hours per unit of work, waiting time, rework, injuries, absenteeism and material waste.

CONCLUSION AND RECOMMENDATIONS

This study found a positive and statistically significant association between sustainable construction practices and perceived labour productivity in Abuja building projects. Improved safety, healthy working conditions, workforce training, waste control and responsible material management were the principal pathways identified by construction professionals. The model accounted for 18.7% of productivity variance, demonstrating a meaningful moderate relationship while leaving substantial variation to other managerial, technical and contextual factors. Given the cross-sectional, self-reported and unadjusted design, the result supports prediction within the sample rather than a definitive causal claim.

The study contributes by translating sustainable construction into four measurable domains and relating their combined practice score to labour productivity in a clearly bounded Abuja setting. Conceptually, the TBL is connected to construction production by showing how environmental resource efficiency, site operations, workforce safety, and institutional and market support can coincide with economic efficiency. Practically, the findings indicate that sustainability should extend beyond certification and post-occupancy performance to method statements, logistics plans, workforce development, material control and daily site supervision.

Contractors and project managers should integrate safety, welfare, waste prevention, storage, access planning and workforce training into production plans. Task-specific instruction should precede unfamiliar materials and methods. Site dashboards should combine perceptual feedback with objective indicators such as installed quantity per labour-hour, labour cost per unit, waiting time, absenteeism, rework, waste volume, near misses and training completion. Clients and consultants should incorporate measurable sustainability and worker-welfare requirements into project briefs, tender evaluation and contract conditions, while testing specifications for local availability, constructability and workforce capability.

Government and professional bodies should strengthen practical standards for construction safety, waste, energy and material management. Public procurement can reward credible sustainability plans and demonstrated workforce competence, but incentives should be accompanied by evidence-based monitoring. Universities, professional institutions and contractors should collaborate on work-based training and Nigerian case studies. Such studies should compare otherwise similar projects with high and low sustainable-practice

ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XV, Issue VIII, August 2026

adoption and document both successful and unsuccessful applications rather than assuming that every sustainable intervention raises output.

Several limitations define the interpretation of the findings. First, Abuja's concentrated urban and regulatory context restricts geographic generalisation. Second, the sampling frame covered registered builders, quantity surveyors, architects and civil engineers; it did not directly represent every contractor, project manager, site supervisor, tradesperson or worker, and incomplete lists or non-response may have introduced selection bias. Third, predictor and outcome data were collected from the same respondents at one time, creating possible common-method and social-desirability bias. Fourth, productivity was perceptual rather than derived from installed quantities, labour-hours, unit labour costs or work-sampling records. Finally, the bivariate model did not control for worker experience and skills, project size and type, technology, management quality, material availability or weather. Future research should use multisource longitudinal data, broader occupational and regional samples, objective productivity measures, and multivariate or matched-project comparisons of high- and low-adoption sites.

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