International Journal of Scientific Research in Social Sciences & Management Studies
p-ISSN: 2579–101X | e-ISSN: 2579–1928
Volume 9, Number 1 May, 2026
IJSRSSMS

Community as Catalyst: The Moderating Role of Community Engagement in the Risk Scoping-Process Automation-Project Success Nexus Among Nigerian Construction Firms

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Article DOI: 10.48028/iiprds/ijsrssms.v9.i1.12

Abstract

Declining project success among Nigerian construction companies manifested through cost overruns, schedule delays, scope creep, and quality deficiencies reflects inadequate risk scoping and insufficient process automation adoption, constructs understudied in developing economy contexts. This study examined the effect of risk scoping and process automation on project success among selected construction companies in Nigeria, with community engagement as a hypothesized moderator. A cross-sectional survey of 491 respondents drawn from a population of 22,800 staff was conducted using Cochran's formula and stratified random sampling. Data were collected via a validated structured questionnaire (Cronbach's alpha: 0.76–0.88; response rate: 86%) and analysed using PLS-SEM at the 5% significance level. Findings established that community engagement did not significantly moderate the effect of risk scoping and process automation on project success ($\beta = -0.014$, $t = 0.555$, $\Delta R^2 = -0.001$, $f^2 = 1.942$, $p > .05$). The study concludes that risk scoping and process automation are direct, autonomous determinants of project success whose influence operates independently of community engagement. Construction firms in Nigeria should therefore prioritise the institutionalization of systematic risk identification, assessment, and mitigation frameworks alongside the strategic integration of workflow, robotic, and safety process automation technologies as the primary levers for improving project performance. Industry regulators should correspondingly develop targeted capacity-building initiatives that embed these capabilities as foundational standards across Nigeria's construction sector.

Keywords: *Community engagement, Process automation, Project success, Risk mitigation, Risk scoping, Robotic process automation, Safety process automation*

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Background to the Study

Road construction occupies a foundational position in national infrastructure development, yet the sector is increasingly characterised by persistent and systemic challenges of cost overruns, schedule delays, scope creep, and quality deficiencies that have significantly undermined project success and eroded confidence in the industry's capacity to translate substantial investment into reliable infrastructure outcomes (Ahmad & Wilkinson, 2025). Globally, the Infrastructure Project Success Index (IPSI, 2023) reported that the proportion of major road projects delivered on budget fell from 62% in 2018 to 49% in 2023, while projects completed on schedule declined from 55% in 2021 to 41% in 2024 with average cost overruns rising to 32% according to the International Construction Performance Index (ICPI, 2024). The World Bank's Infrastructure Quality Index (2025) further documented a 19% increase in structural defects and compliance failures in newly commissioned road projects between 2022 and 2024, while design changes alone contributed to 56.5% of cost overruns and 40% of project delays (IPSI, 2023).

In the United States, nearly 85% of active federal-aid highway projects have exceeded their initial budgets, with average overruns surpassing 18% and delivery timelines extending by approximately 14 months (ARTBA, 2023); California's Gerald Desmond Bridge Replacement recorded a 35% cost overrun of nearly $400 million (California State Auditor, 2024), while Texas highway expansions experienced average scope variations of 28% and cost overruns of 22% (TTI, 2023). Across Europe, road project scope creep affected approximately 45% of projects (Szymczak & Nowak, 2024), the European Construction Industry Federation (FIEC, 2023) recorded country-level cost overruns ranging from 32% in Portugal to 49% in Romania, and only 38% of Cohesion Fund projects in Greece met all delivery criteria against an EU benchmark of 72% (EIB, 2024). In Asia, fewer than 45% of major infrastructure projects met their core objectives for budget, timeline, and quality (Wang & Kim, 2025), with India recording average cost escalations of 42% and schedule overruns of 35% (NHAI, 2023), and China reporting average time overruns of 28% on major highway projects (Zhao & Liu, 2024). In Africa, road infrastructure projects experience an average schedule overrun of 42%, with scope creep affecting 48% of all major road initiatives (African Development Bank, 2024); South Africa recorded cost escalations of 35% (SANRAL, 2024), and Kenya reported time delays of 38% against original contracts (KeNHA, 2025), while only 40% of major road projects in Sub-Saharan Africa are completed within revised budgets, timelines, and quality specifications (CIDB, 2024). These patterns of fiscal inefficiency and declining technical quality reflect a universal and deepening crisis in road construction project success, rooted in inadequate risk scoping practices and limited adoption of process automation technologies.

Nigeria's road construction sector epitomizes this systemic decline with particular severity (Suleiman, 2021). Scope creep affects approximately 52% of public infrastructure projects (Oyewobi & Ganiyu, 2025), while Nigerian road projects experience an average cost overrun of 45% significantly above the continental average (CIDB, 2024). Over 60% of completed road projects have required major rehabilitation within five years of commissioning, schedule overruns averaging 15 months per project are commonplace, and only 40% of Nigerian road projects are ultimately delivered within their revised scope, budget, and quality parameters, signifying a profound and sustained crisis in project success that stifles national development (Federal Ministry of Works, 2024; FERMA, 2024). These entrenched failures are fundamentally attributable to the inadequate application of two critical project management practices risk scoping and process automation. The failure to rigorously implement risk identification, risk assessment, and risk mitigation leaves projects perpetually vulnerable to unforeseen complexities, directly generating the scope creep and budget overruns that characterize Nigerian road projects (Kikwasi & Sospeter, 2022; Omajuwa & Ngwu, 2021; Towobola, 2023). This reactive posture is compounded by a significant lag in technological adoption, wherein the underutilisation of workflow process automation creates administrative inefficiencies and data silos, while the limited deployment of robotic process automation and safety process automation results in lower productivity and elevated incident rates (Hudakova et al., 2022; Mesta et al., 2023). Consequently, this dual deficiency in proactive risk governance and technological enablement generates a predictable cycle of underperformance in which projects consistently fail to meet predefined objectives for scope, cost, time, and quality, thereby eroding overall project success (Adeosun et al., 2025; Suleiman, 2021; Ahmad & Wilkinson, 2025; Kerzner, 2025).

Beyond technical and operational determinants, community engagement has increasingly been recognised as a synergistic moderating force that can either strengthen or constrain the effectiveness of risk scoping and process automation in shaping project success outcomes. Inadequate community engagement frequently leads to public opposition, protests, and work stoppages arising from unmet social and environmental concerns, directly impacting project timelines, budgets, and stakeholder confidence (Muller & Braun, 2021). When communities are excluded from project planning and execution processes, the resulting social friction introduces additional layers of complexity that exacerbate existing deficiencies in risk governance and automation adoption, producing costly redesigns, legal disputes, and quality compromises that further erode overall project success (Ahmad & Wilkinson, 2025; Abal-Seqan et al., 2025; Olusa, 2024). This cycle of social disruption, when overlaid upon already fragile risk management and process automation frameworks, consistently undermines the achievement of project scope, cost, time, and quality objectives a pattern that is particularly pronounced within Nigeria's road construction environment. Against this backdrop, a critical inquiry emerges: does community engagement, as a moderating variable, condition the extent to which risk scoping and process automation jointly determine project success among Nigerian road construction firms? To address this question and proffer evidence-based recommendations for reversing the documented decline in project performance, this study examines the joint effect of risk scoping and process automation on the project success of selected construction companies in Nigeria, moderated by community engagement.

Review of Literature

Community engagement is the systematic, deliberate process of involving local residents, businesses, civic organisations, and other affected stakeholders in project planning, decision-making, and implementation to ensure infrastructure development aligns with community needs, values, and priorities (Bhatti & Nazir, 2024; Huang et al., 2021; Klaus-Rosińska & Iwko, 2021). Beyond information dissemination, it constitutes a structured two-way dialogue that employs public consultations, transparent communication channels, and feedback mechanisms to manage expectations, address concerns, mitigate socio-economic disruptions, and incorporate community input into project execution (Chen et al., 2025). This collaborative paradigm transforms community members from passive observers into active co-creators of infrastructure outcomes, fostering social license to operate and building trust through meaningful inclusion (Alkilani & Loosemore, 2022; Lapidus et al., 2022; Sharma et al., 2021).

Project success is conceptualised as the achievement of project objectives within the interrelated constraints of scope, cost, time, and quality the classical iron triangle augmented by quality requiring that deliverables conform to predefined technical and stakeholder specifications while remaining within approved budgets and schedules (Klarin & Xiao, 2024; Martínez et al., 2024; Ojiako et al., 2023). In the road construction context, this encompasses rigorous compliance with design standards, material specifications, and safety regulations that guarantee structural integrity and long-term durability (El Khatib et al., 2025; Rane et al., 2024). For this study, project success is operationalised through four dimensions. Project scope denotes the degree to which defined boundaries and deliverables resist uncontrolled expansion during execution (Alhassani et al., 2024; Amani & Safarzadeh, 2022; Jeon et al., 2022). Project cost represents the comprehensive monetary expression of all resources required from planning through commissioning, serving as the contractual baseline for budgetary control (Gondia et al., 2022; Huang et al., 2022; Ye et al., 2024). Project time refers to the organised temporal framework of activity durations, sequences, and milestones against which progress, delay, and on-time delivery are assessed (Ebekozien et al., 2023; Hudakova et al., 2022; Stergiopoulos et al., 2022). Project quality denotes the degree to which completed road infrastructure meets or exceeds established technical specifications, performance standards, and stakeholder expectations for functionality, durability, and safety (Bejide et al., 2025).

Risk scoping is defined as the systematic process of identifying, categorizing, and delimiting potential uncertainties and threats across the infrastructure development lifecycle, thereby creating the foundational risk map that guides subsequent assessment, resource allocation, and mitigation planning (Bhatti & Nazir, 2024; Gondia et al., 2022; Wang et al., 2025). It is operationalised through three dimensions in this study. Risk identification constitutes the proactive recognition, cataloguing, and formal documentation of all uncertain events both internal, such as design flaws and material failures, and external, including environmental, regulatory, and financial threats that could affect project objectives (Amani & Safarzadeh, 2022; Dhaniarta et al., 2025; Muneer et al., 2022). Risk assessment represents the structured analytical evaluation of identified risks through qualitative and quantitative methods, translating the risk register into ranked exposures linked to project objectives to enable prioritisation and informed decision-making (Bhatti & Nazir, 2024; Gondia et al., 2022; Yuan et al., 2022). Risk mitigation encompasses the strategic implementation of planned controls and countermeasures designed to reduce the probability of risk occurrence, minimize potential impact severity, and enhance the project's capacity to respond effectively when risks materialize (Okonta et al., 2025; Rane et al., 2024; Tariq et al., 2025).

Process automation is defined as the strategic deployment of technology to execute routine, rule-based tasks with minimal human intervention integrating software systems and hardware to transform manual procedures into auditable, faster, and more reliable construction processes (Oktama & Sidabutar, 2024; Parsafard et al., 2024; Ye et al., 2024). It is operationalised through three dimensions in this study. Workflow process automation refers to the application of digital tools and rule-based systems to orchestrate and monitor repetitive project tasks including scheduling, resource allocation, approval chains, and progress tracking concentrating human effort on judgement and exception handling rather than routine administration (Abal-Seqan et al., 2025; Ferreira et al., 2021; Rifai et al., 2024). Robotic process automation represents the deployment of software robots and intelligent automation technologies that mimic human interactions with digital systems to execute repetitive administrative and operational functions including data extraction, system navigation, and cross-platform communication with speed, accuracy, and consistency (Amani & Safarzadeh, 2022; Cıracıoglu & Yaman, 2021; Hart, 2024). Safety process automation constitutes the systematic implementation of automated technologies and control systems to proactively monitor, enforce, and manage occupational health and safety protocols across the construction lifecycle, enhancing hazard detection and risk control through technology-driven surveillance and automated enforcement mechanisms (Green & Dikmen, 2022; Kikwasi & Sospeter, 2022; Sadeghi et al., 2022).

Risk Scoping, Process Automation, Project Success and Community Engagement

Empirical evidence broadly supports a statistically significant moderating role of community engagement in the relationship between risk scoping, process automation, and project success. Studies consistently demonstrate that projects incorporating structured community engagement mechanisms exhibit stronger alignment between identified risks and mitigation outcomes, producing measurably higher success rates across cost, time, and quality dimensions (Amoah & Sibelekwana, 2022; Dahalan et al., 2025; Muneer et al., 2022; Rane et al., 2021; Tariq et al., 2025). When community stakeholders are actively consulted during risk identification and prioritisation, the scope of risks considered expands to encompass socio-environmental and operational concerns that would otherwise be overlooked, and this broadened risk intelligence significantly improves project delivery outcomes (Ebekozien et al., 2023; Ferreira et al., 2021; Kermanshachi et al., 2020). Several studies further confirm that community engagement meaningfully conditions how risk scoping translates into project success, with interaction models yielding significant moderation coefficients and improved explanatory power when engagement is included as a boundary condition (Amani & Safarzadeh, 2022; Hudakova et al., 2022; Klarin & Xiao, 2024; Martínez et al., 2024; Olusa, 2024). Notably, Sadeghi et al. (2022) and Huang et al. (2021) demonstrate that community engagement not only strengthens the magnitude of the risk scoping–project success relationship but can alter its direction in contexts where top-down risk assessments previously predicted lower success with engagement rendering risk-informed decisions more context-sensitive and raising success probabilities accordingly.

The moderating influence of community engagement extends equally to the process automation–project success nexus. Projects that combine technical automation strategies with parallel community engagement achieve greater stakeholder acceptance, fewer social disruptions, and superior performance outcomes compared with those relying solely on technological deployment (Adegoke et al., 2024; Olusa, 2024; Omajuwa & Iheama, 2022; Sundara et al., 2021; Zaray et al., 2022). Specifically, community involvement mitigates resistance to automated change, surfaces local process knowledge that refines automation design, and thereby amplifies the positive effects of automation on schedule adherence and construction quality effects that are statistically significant in interaction models (Liang & Liu, 2022; Luo et al., 2021). Ajmal et al. (2022), Can Saglam et al. (2021), and Afieroho et al. (2023) collectively underscore that the technical advantages of automation are consistently amplified when community stakeholders participate in shaping implementation, producing positive and significant moderation coefficients across diverse project contexts. Complementary evidence from Adekeye (2022) and Diaz-Lopez et al. (2021) further confirms that integrating stakeholder engagement into automation planning improves usability, compliance, and sustainability of automated solutions, yielding tangible improvements in project cost, time, and quality performance and substantiating community engagement as a theoretically and practically meaningful moderator in the automation–project success relationship.

Research Conceptual Model

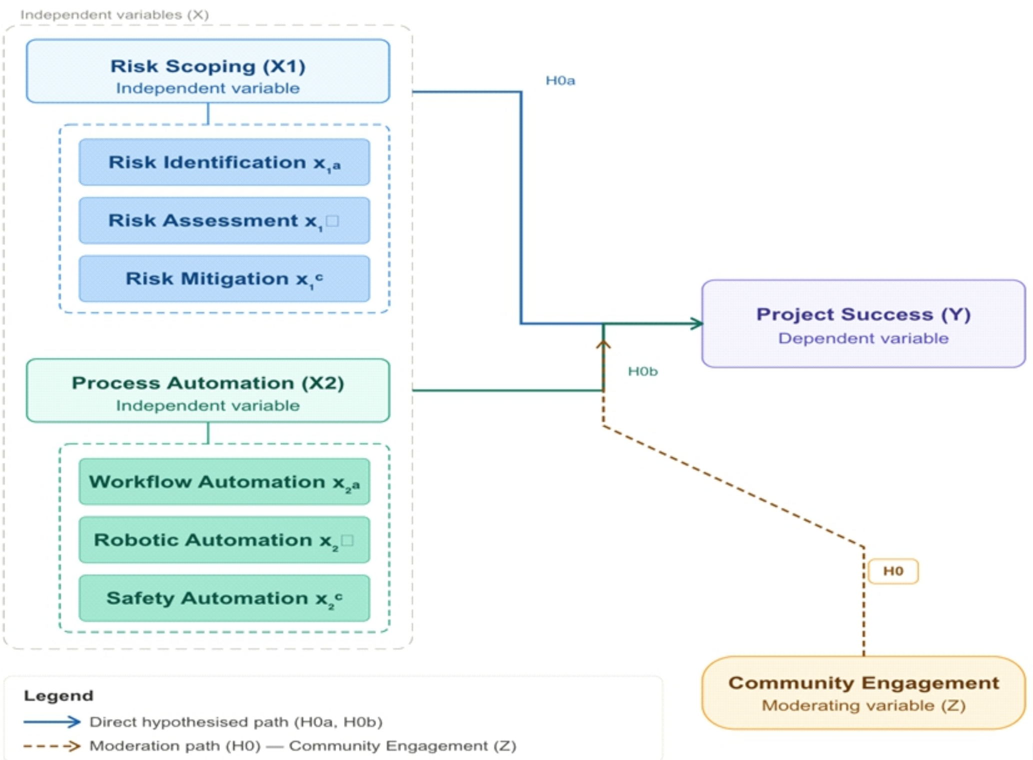


Figure 1: Research Conceptual Model (2026)

Conceptual framework illustrates the hypothesised joint effect of Risk Scoping (X1) and Process Automation (X2) on Project Success (Y) among selected construction companies in

Nigeria, with Community Engagement (Z) hypothesised as a moderating variable. Risk Scoping is operationalised through risk identification, risk assessment, and risk mitigation, representing a sequential governance cycle that moves from the detection of project threats through their evaluation to the deployment of corrective responses. Process Automation is correspondingly operationalised through workflow automation, robotic process automation, and safety automation, collectively spanning the digitisation of routine tasks, the mechanisation of high-volume operations, and the automated enforcement of health and safety compliance on construction sites.

Project Success, the dependent variable, is measured across four performance dimensions of project scope, project cost, project time, and project quality, extending the classical iron triangle to incorporate quality as a fourth and equally critical criterion of project delivery performance. Community Engagement, by contrast, does not function as a direct predictor of project success but as a boundary condition that amplifies or attenuates the extent to which risk scoping and process automation translate into favourable project outcomes, contingent on the level of meaningful stakeholder engagement within the host community environment. The model advances three null hypotheses for empirical testing: H0a, which posits that Risk Scoping has no significant effect on Project Success; H0b, which posits that process automation has no significant effect on project success; and H0, which posits that community engagement does not significantly moderate those relationships. Rejection of all three nulls would provide empirical confirmation that both risk governance and automation capabilities are robust determinants of construction project performance and that the strength of their influence is meaningfully conditioned by the degree of community engagement.

Theoretical Review

This study is theoretically anchored in Contingency Theory, pioneered by Fiedler (1964) and systematized by Donaldson (2001), which posits that no universally optimal approach to organisational management exists; rather, effectiveness is achieved when management practices, structures, and strategies are aligned with prevailing situational factors, including environmental uncertainty, task complexity, and technological dynamics. Foundational contributors to this theoretical tradition Burns and Stalker (1961), who linked organisational form to environmental uncertainty; Woodward (1965) and Lawrence and Lorsch (1967), who demonstrated how technological and environmental differentiation necessitate distinct structural responses; and Fiedler (1964), whose fit-based leadership framework established the conceptual logic of context-dependence collectively affirm that management strategies must be adapted to situational conditions rather than applied universally. This logic was subsequently extended into construction project management by Turner and Müller (2003) and Hartmann (2006), who argue that risk scoping strategies and automation practices must be calibrated to project complexity, stakeholder context, and regulatory environment to optimise outcomes across scope, cost, time, and quality dimensions.

The theory's relevance to this study is threefold. First, it provides a normative framework for specifying when and why particular configurations of risk identification, risk assessment, risk mitigation, and process automation encompassing workflow, robotic, and safety automation are most likely to produce favourable project success outcomes among Nigerian construction firms. Second, it positions community engagement as a contingent boundary condition whose moderating influence on the risk scoping–process automation–project success nexus is itself situationally determined, rendering the non-significant moderation finding of this study theoretically interpretable: in the Nigerian construction context, the prevailing situational configuration may render community engagement a contextually peripheral rather than structurally decisive factor, consistent with Contingency Theory's assertion that fit between practice and context, not the presence of any single variable, determines outcomes. Third, it enables divergent performance results to be interpreted as products of contextual misfit rather than random failure, aligning with contemporary principle-based and context-sensitive risk management standards (PMI, 2021). Notwithstanding acknowledged limitations including its tendency to oversimplify complex organisational realities through a one-best-fit assumption (Donaldson, 2001; Pennings, 1992), its limited predictive power in highly dynamic environments (Otley, 1980), and its relative neglect of human, cultural, and political influences on project outcomes (Schoonhoven, 1981). Contingency Theory retains compelling analytical relevance as the theoretical scaffolding for this study's conceptual and empirical design.

Methodology

This study adopted a positivist research philosophy grounded in objectivist ontology, employing deductive reasoning and a cross-sectional survey design. The target population comprised 22,800 employees, from which a representative sample of 491 respondents was derived using Cochran's (1977) formula and selected through stratified random sampling to ensure proportional organisational representation and minimise selection bias. Data were collected via a validated structured questionnaire measured on a six-point Likert scale ranging from Very High (6) to Very Low (1) with a neutral midpoint deliberately excluded to compel directional responses and enhance inter-item variance (Garland, 1991). Cronbach's alpha reliability coefficients ranged from 0.76 to 0.88 across all constructs, confirming acceptable to strong internal consistency (Nunnally, 1978), and an overall response rate of 86% was achieved, substantially exceeding the 70% threshold classified as very good in the survey literature (Mugenda & Mugenda, 2003), thereby affirming the representativeness and analytical adequacy of the dataset. The independent variables of risk scoping, operationalised through risk identification, risk assessment, and risk mitigation; and process automation, operationalised through workflow, robotic, and safety process automation alongside the dependent variable of project success, operationalised through project scope, cost, time, and quality, were analysed using descriptive statistics and Partial Least Squares Structural Equation Modelling (PLS-SEM) via SmartPLS at the 5% significance level. PLS-SEM enabled simultaneous estimation of measurement and structural model parameters, yielding path coefficients, bootstrapped t-statistics, and R^2 values that assess the magnitude, direction, and statistical significance of each predictor's influence on project success. Multiple regression equations were further developed to examine the independent and joint predictive contributions of risk scoping and process automation, with the structural relationships specified as follows:

Variables Identification

Y = f (X)

Y = f (XZ)

Y = Project Success (PS) Dependent Variable

X1 = Risk Scoping (RS) Independent Variable

X2 = Process Automation (PA) Independent Variable

Z = Community Engagement [CE] Moderating Variable

$Y = (y_1, y_2, y_3, y_4)$

Where:

Y = Project Success

$X1 = (x_{1a}, x_{1b}, x_{1c})$	$X2 = (x_{2a}, x_{2b}, x_{2c})$
Where:	Where:
X1 = Risk Scoping	X2 = Process Automation
x_{1a} = Risk Identification	x_{2a} = Workflow Process Automation
x_{1b} = Risk Assessment	x_{2b} = Robotic Process Automation
x_{1c} = Risk Mitigation	x_{2c} = Safety Process Automation

Functional Relationship

Lower-Order Constructs (Reflective Measurement Models)

$X1 = f(x_{1a}, x_{1b}, x_{1c})$

$X2 = f(x_{2a}, x_2b, x_{2c})$

Higher-Order Constructs (Formative Models) / Direct and Moderated Effects Model

$Y = f(X1, X2, Z, X1\times Z, X2\times Z)$ .... Eqn.

Structural Equation Models for PLS-SEM Analysis

Structural Model (Inner Model)

Hypothesis (H_0): Direct and Moderated Effects on Project Success

$Y = \beta_0 + \beta_1 X1 + \beta_2 X2 + \beta_3 Z + \beta_4(X1\times Z) + \beta_5(X2\times Z) + \varepsilon_i$ -------------------------------- Eqn.

Parameters

λ = Outer loadings (factor loadings for reflective indicators at the lower-order level)

γ = Weights (outer weights for formative indicators at the higher-order level)

β_0 = Intercept (constant term)

β_1, β_2 = Path coefficients for the direct effects of X1 and X2 on Y

β_3 = Path coefficient for the direct effect of Z on Y

β_4, β_5 = Path coefficients for the moderation effects (X1*Z and X2*Z) on Y

δ = Measurement error terms (outer model residuals for reflective indicators)

ε_i = Structural error term (inner model residual)

Data Analysis, Results and Discussion

491 questionnaires were administered to respondents drawn from selected construction companies in Nigeria, 422 were correctly completed and returned, yielding a response rate of 86% with the remaining 69 copies (14%) unreturned and consequently excluded from the final analysis. This response rate substantially exceeds the thresholds prescribed in the survey research literature, wherein 60% is considered adequate and 70% and above is classified as very good (Mugenda & Mugenda, 2003; Sekaran & Bougie, 2016), and is therefore adjudged excellent lending strong confidence to the representativeness of the dataset and its adequacy for supporting robust descriptive and inferential statistical analyses.

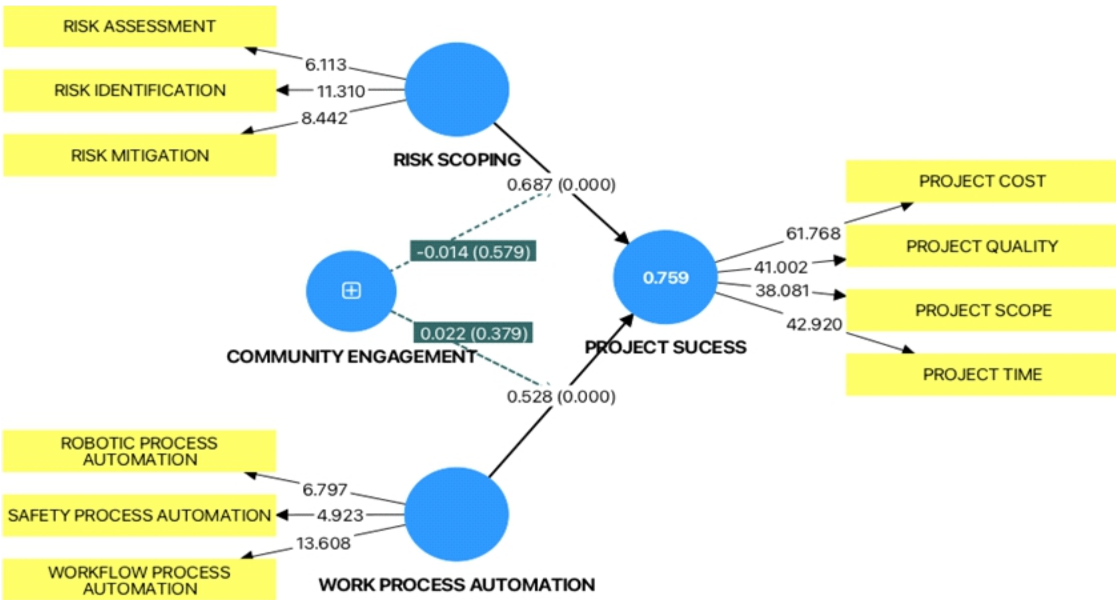
Restatement of Hypothesis

H0: Risk scoping and process automation dimensions have no significant effect on project success moderated by community engagement

In testing the study hypothesis, Partial Least Square Structural Equation Modelling (PLS-SEM) was deployed with risk scoping and process automation dimensions as independent variable, project success as the dependent variable and community engagement as moderating variable. The results of the analysis and parameter estimates obtained are presented below: Figure 2 displays the outcomes of the bootstrapping procedure, illustrating the obtained results and their implications for the structural model analysis for this study objective which examined the effect of risk scoping and process automation on project success moderated by community engagement.

Figure 2:

Bootstrapped Structural Model for the study hypothesis



SmartPLS bootstrapping output illustrating the moderating effect of community engagement on the relationship between risk scoping, process automation, and project success.

Path Coefficients and Hypothesis Testing

This section examines the direct and moderating effects of risk scoping, process automation, and community engagement on project success, as specified *under the study hypothesis*. The structural relationships were estimated using the Partial Least Squares Structural Equation Modelling (PLS-SEM) technique, and statistical significance was assessed through a bootstrapping procedure. Decisions are based on a 5% significance level (two-tailed), where β represents the standardised path coefficient and SE denotes the standard error.

Table 1: Path Coefficients for the study hypothesis (Community Engagement as Moderator)

Structural Path	β	SE	t-value	p-value	Decision
Community Engagement → Project Success	0.026	0.024	1.091	.275	Not Supported
Community Engagement × Risk Scoping → Project Success	−0.014	0.026	0.555	.579	Not Supported
Community Engagement × Work Process Automation → Project Success	0.022	0.025	0.880	.379	Not Supported
Risk Scoping → Project Success	0.687	0.025	27.344	< .001	Supported
Work Process Automation → Project Success	0.528	0.028	18.594	< .001	Supported

Source: Researcher's Field Survey Results (2026).

The results presented in Table 1 show that risk scoping and work process automation both exert positive and statistically significant direct effects on project success. Specifically, risk scoping demonstrates a strong positive effect on project success ($\beta = 0.687$, $t = 27.344$, $p < .001$), indicating that improved practices in risk identification, assessment, and mitigation substantially enhance overall project success outcomes. Similarly, work process automation has a positive and significant influence on project success ($\beta = 0.528$, $t = 18.594$, $p < .001$), suggesting that the adoption of automated workflows, robotic processes, and safety automation contributes meaningfully to successful project delivery.

In contrast, community engagement does not exhibit a statistically significant direct effect on project success ($\beta = 0.026$, $p = .275$). Furthermore, the interaction effects between community engagement and risk scoping ($\beta = -0.014$, $p = .579$), as well as between community engagement and work process automation ($\beta = 0.022$, $p = .379$), are not statistically significant. The negative sign of the interaction between community engagement and risk scoping indicates a weak inverse moderating tendency; however, the effect is negligible and statistically insignificant. Likewise, the positive interaction between community engagement and work process automation is weak and does not reach statistical significance. Overall, these findings indicate that while risk scoping and process automation independently enhance project success, community engagement does not significantly alter the strength or direction of these relationships within the moderated model. Consequently, there is no empirical evidence to support a moderating role of community engagement in the relationship between risk scoping, process automation, and project success at the 5% significance level.

Explanatory Power of the Structural Model (R^2) and Model Significance (F-statistic)

The explanatory power of the moderated structural model was assessed using the coefficient of determination (R^2) and the adjusted R^2, which indicate the proportion of variance in Project Success explained by the predictor constructs. In PLS-SEM, R^2 values of approximately 0.25, 0.50, and 0.75 are commonly interpreted as weak, moderate, and substantial, respectively (Hair et al., 2019). Additionally, the overall significance of the moderated model was evaluated using the F-statistic, which tests whether the predictors, including interaction terms, jointly explain a statistically significant portion of the variance in the endogenous construct.

Table 2: R^2, Adjusted R^2 and F-Statistic for Project Success (Community Engagement as Moderator)

Endogenous Construct	**R^2**	**Adjusted R^2**	**F-statistic**
Project Success	0.759	0.756	$F(3,418) = 438.72$, $p < 0.05$

Source: Researcher's Field Survey Results (2026).

The results in Table 2 indicate that the moderated model explains 75.9% of the variance in Project Success ($R^2 = 0.759$). The adjusted R^2 value of 0.756 suggests that the model retains its explanatory strength after accounting for the number of predictors, indicating no overfitting.

Effect Size (f^2)

Beyond statistical significance and explanatory power, the substantive contribution of each predictor and interaction term to Project Success was assessed using the effect size (f^2). In the PLS-SEM framework, f^2 measures the change in the coefficient of determination (R^2) when a specific exogenous construct is omitted from the model, thereby indicating its practical importance. Following Cohen's (1988) guidelines, f^2 values of 0.02, 0.15, and 0.35 are interpreted as small, medium, and large effect sizes, respectively.

Table 3: Effect Size (f^2) for Project Success (Community Engagement as Moderator)

Structural Path	**f^2**	**Effect Size Interpretation**
Community Engagement → Project Success	0.003	Negligible
Community Engagement × Risk Scoping → Project Success	0.001	Negligible
Community Engagement × Work Process Automation → Project Success	0.002	Negligible
Risk Scoping → Project Success	1.942	Large
Work Process Automation → Project Success	1.145	Large

Source: Researcher's Field Survey Results (2026).

The results in Table 3 indicate that Risk Scoping and Work Process Automation exert very large substantive effects on Project Success, with f^2 values of 1.942 and 1.145, respectively. These effect sizes far exceed the conventional threshold for a large effect, underscoring the dominant role of structured risk-related practices and automation-driven processes in driving project success outcomes. In contrast, Community Engagement exhibits a negligible effect size on Project Success ($f^2 = 0.003$), indicating that its direct contribution to the explained variance is practically insignificant. Similarly, the interaction terms Community Engagement × Risk Scoping ($f^2 = 0.001$) and Community Engagement × Work Process Automation ($f^2 = 0.002$) also demonstrate negligible effect sizes. This implies that community engagement does not meaningfully alter the strength of the relationships between risk scoping, process automation, and project success.

Predictive Relevance (Q^2predict)

The predictive relevance of the moderated structural model was assessed using the PLS-Predict (Q^2predict) procedure. Predictive relevance evaluates the model's out-of-sample prediction capability by comparing prediction errors generated by the PLS-SEM model against those obtained from a naïve benchmark. In line with PLS-SEM guidelines, Q^2predict values greater than zero indicate that the model has predictive relevance, while higher values reflect stronger predictive accuracy (Hair et al., 2019).

Table 4: PLS-Predict Results for Project Success (Community Engagement as Moderator)

Endogenous Construct	Q^2predict	RMSE	MAE
Project Success	0.749	0.504	0.406

Source: Researcher's Field Survey Results (2026).

The results presented in Table 4 show that the moderated model yields a Q^2predict value of 0.749 for Project Success. This value is substantially above zero, indicating strong predictive relevance of the model. The associated prediction error metrics further supports this conclusion. The RMSE value of 0.504 and MAE value of 0.406 suggest that the predicted values of project success closely approximate the observed values, reflecting high out-of-sample predictive accuracy.

Simple Slope Analysis of the Moderating Role of Community Engagement

To further elucidate the nature of the moderating role of community engagement in the relationships between risk scoping, work process automation, and project success, a simple slope analysis was conducted. Simple slope analysis is commonly employed in moderation studies to visually demonstrate how the relationship between an independent variable and a dependent variable behaves at different levels of a moderator, typically at one standard deviation below the mean, at the mean, and one standard deviation above the mean. This approach complements the interaction term results by providing a graphical representation of conditional effects.

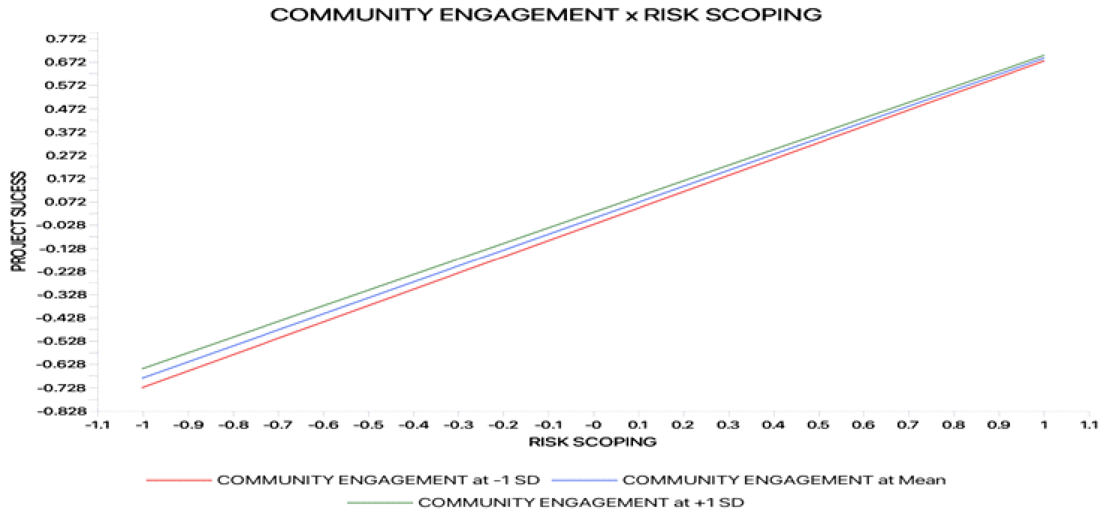


Figure 3: Simple Slope of Risk Scoping and Community Engagement on Project Success

Figure 3 presents the simple slope plot illustrating the interaction between Risk Scoping and Community Engagement on Project Success. In this figure, Project Success is plotted against Risk Scoping at low (−1 SD), average (mean), and high (+1 SD) levels of Community Engagement. The figure shows that Project Success increases steadily as Risk Scoping improves across all three levels of Community Engagement. The slopes of the regression lines are positive and closely aligned, with only slight vertical separation among the lines corresponding to different levels of the moderator.

The near-parallel indicates that although higher levels of Community Engagement are associated with marginally higher predicted levels of Project Success, Community Engagement does not substantially alter the strength or direction of the relationship between Risk Scoping and Project Success. This visual pattern is consistent with the structural model results, which revealed that the interaction term between Community Engagement and Risk Scoping was statistically insignificant. Consequently, the simple slope analysis confirms that the positive effect of Risk Scoping on Project Success remains stable irrespective of variations in Community Engagement.

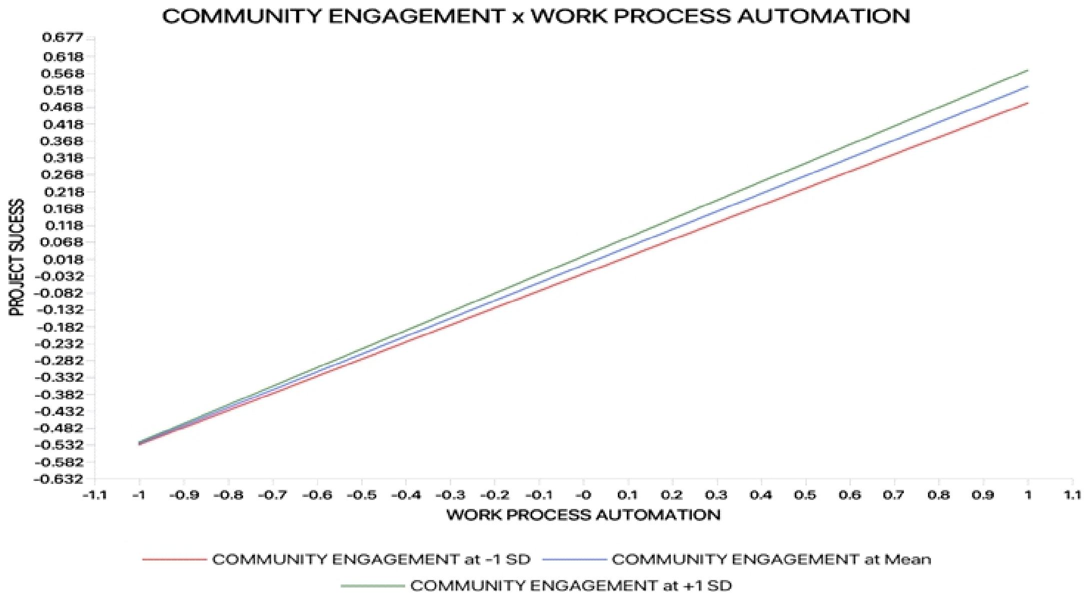


Figure 4: Simple Slope of Work Process Automation and Community Engagement on Project Success

Figure 4 displays the simple slope plot for the interaction between work process automation and community engagement in predicting project success. in this figure, project success is plotted against work process automation at low, mean, and high levels of community engagement. The graphical results show a clear positive relationship between work process automation and project success across all levels of the moderator. Similar to the previous interaction, the slopes the different moderator levels. although projects characterised by higher levels of community engagement exhibit slightly higher predicted values of project success across the range of work process automation, the similarity of the slopes suggests that community engagement does not meaningfully intensify or weaken the effect of work process automation on project success. This observation aligns with the insignificant interaction effect obtained in the structural model, further indicating that community engagement does not operate as a conditioning factor in the automation–project success relationship. Overall, the simple slope analyses presented in Figures 3 and 4 provide visual confirmation of the earlier statistical findings. While Risk Scoping and Work Process Automation each level of Community Engagement. The consistency of the slopes across low, average, and high levels of the moderator demonstrates that community engagement does not significantly influence how this predictor constructs translate into project success outcomes. Thus, the simple slope analysis reinforces the conclusion that Community Engagement does not serve as an effective moderator in the specified model.

Decision on the Study Hypothesis

The study hypothesis examined whether community engagement moderates the relationship between risk scoping, work process automation, and project success. The decision on this hypothesis is based on the combined evidence from the structural path coefficients, changes in explanatory power (R^2 and adjusted R^2), effect sizes (f^2), predictive relevance (Q^2predict), and the simple slope analyses. The structural model results indicate that the direct effects of Risk Scoping and Work Process Automation on Project Success remain positive and statistically significant in the presence of Community Engagement. Specifically, Risk Scoping continues to exert a strong positive influence on Project Success, while Work Process Automation also maintains a statistically significant positive effect. These findings confirm the robustness of the main effects observed under the study hypothesis. However, the interaction effects involving community engagement, namely community engagement × risk scoping and community engagement × work process automation, were found to be statistically insignificant. The associated path coefficients were small in magnitude and accompanied by non-significant t-statistics and p-values exceeding the 0.05 threshold. This indicates that community engagement does not significantly change either the strength or the direction of the relationships between the predictor constructs and project success.

A comparison of the model's explanatory power before and after the introduction of the moderator further supports this conclusion. Under the study hypothesis (unmoderated model), the adjusted R^2 for Project Success was 0.757. Following the inclusion of community engagement and its interaction terms in the study hypothesis, the adjusted R^2 marginally decreased to 0.756. This negligible change suggests that of community engagement as a moderator does not meaningfully improve the model's ability to explain variations in Project Success. Similarly, the Q^2predict value remains high, indicating strong predictive relevance, but without any substantive improvement attributable to the moderating effects.

The effect size results reinforce this interpretation. While risk scoping and work process automation continue to demonstrate very large effect sizes on Project Success, the effect sizes associated with Community Engagement and its interaction terms are negligible. This indicates that, from a practical standpoint, Community Engagement does not contribute additional explanatory value as a moderator beyond the direct effects already captured in the model. The simple slope analyses further corroborate these statistical findings. The graphical plots show that the positive relationships between Risk Scoping and Project Success, as well as between work process automation and project success, remain largely consistent across low, average, and high levels of community engagement. The near-parallel slopes observed in the figures confirm that community engagement does not condition these relationships in any meaningful way. Based on the foregoing evidence, the study hypothesis is not supported. While community engagement is conceptually relevant to project environments, it does not significantly moderate the effects of risk scoping and work process automation on project success in the sampled construction firms. Accordingly, the null hypothesis stating that risk scoping and work process automation dimensions have no significant effect on project success when moderated by community engagement is retained.

Structural Model Expression (Project Success – Community Engagement as Moderator)

The estimated structural relationship for project success under the community engagement–moderated model is expressed as:

$$PS = \beta_0 + 0.687RS + 0.528PA + 0.026CE - 0.014(RS \times CE) + 0.022(PA \times CE) + \varepsilon$$

Where:
PS = Project Success
RS = Risk Scoping
PA = Process Automation
CE = Community Engagement
RS × CE = Interaction between Risk Scoping and Community Engagement
PA × CE = Interaction between Process Automation and Community Engagement
β_0 = Intercept term
ε = Error term

This structural equation indicates that Risk Scoping and Process Automation continue to exert strong, positive, and statistically significant effects on Project Success even after the introduction of Community Engagement into the model. Risk Scoping remains the dominant predictor, followed by Process Automation, consistent with the unmoderated model results reported under the study hypothesis. However, the coefficients associated with community engagement and its interaction terms are small in magnitude and statistically insignificant. The negative coefficient for the risk scoping × community engagement interaction suggests a weak dampening tendency, while the positive coefficient for the process automation × community engagement interaction indicates a marginal reinforcing tendency. nevertheless, neither interaction effect is statistically meaningful. this implies that variations in alter how risk scoping or process automation translates into project success outcomes. Overall, the structural model confirms that project success in the sampled construction firms is primarily driven by internal managerial and operational capabilities, particularly structured risk scoping and automation practices, rather than by the moderating influence of community engagement.

Discussion

The PLS-SEM path analysis established that community engagement did not produce a statistically significant individual moderation effect on the relationship between risk scoping, process automation, and project success among selected construction companies in Nigeria. This finding does not diminish the importance of community engagement within the Nigerian construction context but indicates that its value operates through a different mechanism than direct moderation of technical project management practices. Conceptually, risk scoping and process automation are internally oriented management capabilities governing how project teams organise information, automate workflows, and control project variables within the project organisation, whereas community engagement is an externally oriented relational practice governing how the project interfaces with its social environment. The non-significant moderation finding reflects a functional separation between these two domains in Nigerian construction, wherein community engagement practised independently of the technical management systems it theoretically complements does not consistently condition the effectiveness of risk scoping and automation in delivering project success outcomes (Atencio et al., 2024; Majumdar et al., 2021).

The Nigerian construction industry context provides important explanatory grounding for this result. Community engagement activities on public-sector projects are frequently conducted as regulatory compliance exercises environmental impact assessment hearings, community liaison officer appointments, and right-of-way consultations conducted on compressed timescales with predetermined outcomes generating documentation for regulatory submission rather than actionable risk intelligence or operational feedback that project managers subsequently embed in risk registers or automation designs. In this structural context, community engagement produces social legitimacy outputs without consistently generating the technical inputs necessary to condition the risk scoping–project success relationship. Conway (2025) and Shahed et al. (2021) observe that poorly structured consultation processes may delay decision-making and dilute managerial control, while Da et al. (2021) and Rahi (2021) note that unmanaged stakeholder demands can introduce scope creep, political interference, and resource diversion dynamics that weaken rather than strengthen the beneficial effects of risk scoping and automation, and which represent lived project realities across Nigeria's complex community-contractor environments.

The empirical literature nonetheless confirms conditions under which community engagement produces statistically significant moderation effects, and these findings provide important contextual qualification. Amani and Safarzadeh (2022), Martínez et al. (2024), Qais (2021), and Xing et al. (2023) demonstrate that community engagement significantly moderates the risk scoping–project success relationship where engagement mechanisms are structurally integrated into the risk management process rather than conducted in parallel to it. Ferreira et al. (2021), Ebekozien et al. (2023), and Kermanshachi et al. (2020) establish that active community consultation during risk identification expands the scope of risks considered to include socio-environmental concerns seasonal flooding patterns, informal land use rights, local labour availability that technical assessments typically overlook, and that this broadened risk intelligence produces measurable delivery improvements. Similarly, Ajmal et al. (2022), Can Saglam et al. (2021), and Afieroho et al. (2023) confirm that community involvement in automation deployment mitigates resistance, surfaces local process knowledge, and amplifies the performance benefits of technology adoption, while Adekeye (2022) establishes that it is the quality and structural integration of community engagement not merely its occurrence that determines whether it produces a measurable moderation effect on project outcomes (Klarin & Xiao, 2024; Sadeghi et al., 2022).

From a Contingency Theory perspective, the non-significant moderation finding refines rather than contradicts the proposition that organisational performance depends on fit between management practices and contextual variables. It contributes an important qualification: the moderating strength of a contextual variable is contingent on its structural integration within the management system rather than its mere presence in the project environment. When risk scoping and process automation are robustly implemented, they generate internally sufficient performance improvements through their own operational logic without requiring community engagement to amplify those effects. Community engagement delivers its most powerful contribution to project success not as a standalone social compliance activity managed separately from the project management office, but as a structurally embedded input into technical management processes with community risk intelligence feeding directly into formal risk registers, operational feedback shaping workflow automation designs, and community safety observations informing automated monitoring system calibration. Accordingly, this study does not reject the null hypothesis and concludes that the pathway through which community engagement most powerfully contributes to project success in Nigerian construction runs through its deliberate structural integration into risk management and automation systems, rather than through its operation as an independent moderating variable detached from the project's technical governance architecture.

Conclusion and Recommendation

This study examined the effect of risk scoping and process automation on the project success of selected construction companies in Nigeria, with community engagement hypothesised as a moderating variable. Employing a quantitative cross-sectional survey design and Partial Least Squares Structural Equation Modelling (PLS-SEM), the study established that both risk scoping operationalised through risk identification, risk assessment, and risk mitigation and process automation operationalised through workflow, robotic, and safety process automation had positive and statistically significant direct effects on project success across the four performance dimensions of scope, cost, time, and quality. Community engagement, however, did not produce a statistically significant moderation effect on these relationships, indicating that the influence of risk scoping and process automation on project success operates independently of the level of community engagement within the studied context.

Conceptually, the study advances a novel integrated framework that reconceptualizes risk scoping and process automation not as isolated management practices but as complementary strategic capabilities whose combined and systematic application enhances project delivery outcomes addressing a critical gap in prior literature that has predominantly examined risk management and automation in isolation from one another. The non-significant moderation finding further clarifies the conceptual boundary conditions of community engagement's contribution to project success, establishing that its value in the Nigerian construction context is contingent on structural integration into technical management systems rather than parallel operation as an independent social process. Theoretically, the findings extend Contingency Theory within the underexplored domain of construction project management in Sub-Saharan Africa, demonstrating that while risk scoping and process automation are robust autonomous determinants of project success, the moderating influence of external contingencies is itself situationally determined a refinement of the theory's alignment tenet that advances its applicability to developing economy construction contexts.

Based on these findings, construction companies in Nigeria are recommended to prioritise the institutionalisation of comprehensive risk scoping frameworks embedding systematic risk identification, rigorous assessment protocols, and proactive mitigation strategies as mandatory project governance requirements while simultaneously advancing the strategic integration of workflow, robotic, and safety process automation technologies as primary and direct levers for improving project performance. Community engagement should be deliberately restructured from a regulatory compliance activity into a technically embedded project management input, with community-sourced risk intelligence formally incorporated into risk registers, probability-impact matrices, and mitigation plans to maximise its contribution to project success. Regulatory authorities and industry associations should correspondingly develop capability-building programmes, technology adoption incentives, and procurement governance frameworks that strengthen risk scoping and automation as foundational pillars of construction project performance in Nigeria's built environment. Future research should investigate the mediating mechanisms through which risk scoping and process automation individually and jointly translate into project success outcomes, examining whether constructs such as organisational learning capability, digital readiness, and project team competence serve as intervening pathways that explain the process by which these capabilities produce performance improvements among Nigerian construction firms. Scholars are further encouraged to extend the present framework by incorporating additional moderating variables including contract type, project complexity, procurement governance quality, and firm size that may condition the strength of the risk scoping–project success and automation–project success relationships in ways not captured by the current model.

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