ISSN: 2524-1354 (Online), ISSN: 2519-7851 (Print)
Africa Habitat Review Journal
Volume 21 Issue 1 (April 2026)
http://uonjournals.uonbi.ac.ke/ojs/index.php/ahr

Construction Delays in Rwanda's Local Government Projects: *A Statistical Framework for Management*

***Niyomfura Eric, Adeline Dindi and Abednego O. Gwaya**
https://orcid.org/0009-0005-2726-4537

Received on 9th December, 2025; Received in revised form 6th January, 2026; Accepted on 11th February, 2026.

Abstract

Rwanda's construction sector, contributing 8.2% to GDP, faces persistent delays threatening Vision 2050 targets. This study examines delay factors in local government infrastructure projects using a mixed-methods approach involving stakeholders from Nyagatare and Musanze districts. Findings reveal that financial factors are the primary drivers of construction delays, showing a strong positive correlation with delay occurrence (r = 0.783, p < 0.001). Multiple regression analysis further establishes that financial factors exert the greatest predictive influence on project delays compared to administrative, technical, and environmental factors. Based on these findings, the Rwanda Construction Delay Management Framework (RCDMF) was developed, projecting up to a 60% reduction in project delays when fully implemented. The study recommends strengthening pre-project financial planning, enforcing timely payment systems through IFMIS, and enhancing technical capacity through targeted training to improve delay management in Rwanda's local government construction projects.

Keywords: Construction delays, local government projects, financial factors, statistical prediction, Rwanda; Vision 2050, IFMIS, delay management framework

INTRODUCTION

The construction industry in Rwanda is a fundamental pillar of economic development, contributing 8.2% to the national Gross Domestic Product (GDP) and sustaining an annual growth rate of 12% since 2015 (Ministry of Infrastructure, 2022). This sector is instrumental to Rwanda's Vision 2050, a comprehensive national development blueprint targeting middle-income status by 2035 and high-income status by 2050 through infrastructure-led growth, urbanization, and enhanced connectivity. Key initiatives such as the Kigali Innovation City, Bugesera International Airport, district hospitals, secondary schools, and rural road networks exemplify the industry's potential to transform socioeconomic outcomes. At the local government level, the Local Administrative Entities Development Agency (LODA) coordinates infrastructure projects worth approximately 850 million RWF annually across Rwanda's 30 districts, directly supporting the IMIHIGO performance contract system where district mayors commit to specific infrastructure targets annually.

However, this ambitious agenda faces critical challenges: approximately 75% of local government construction projects experience moderate to major delays, defined as timeline extensions exceeding 25% of the original schedule (MININFRA, 2022). Notable examples include the Nyagatare District Hospital, which faced an 18-month delay beyond its 24-month schedule, resulting in a 45% budget overrun from 2.8 billion to 4.1 billion RWF; the Musanze stadium project, delayed by 14 months with a 35% cost escalation; and multiple school construction projects in the Eastern Province that missed IMIHIGO targets for three consecutive years (2020-2022). These delays cascade into broader development impacts: delayed hospitals compromise healthcare access for 200,000+ citizens, school delays affect 15,000+ students annually, and road project overruns limit agricultural market connectivity in rural areas.

Despite extensive research on construction delays globally, a critical research gap exists in Rwanda's local government construction sector. While

**Corresponding author:*
***Niyomfura Eric** Department of Construction Management, Jomo Kenyatta University of Agriculture and Technology, Kigali Campus, Rwanda*
Email: eniyomfura@rocketmail.com

international studies have identified general delay factors, the specific mechanisms through which financial, administrative, technical, and environmental factors interact within Rwanda's unique governance structures—particularly the LODA coordination framework, IMIHIGO performance contracts, and decentralized implementation systems—remain poorly understood. Furthermore, no empirical study has quantified the predictive relationships between these factors and delay outcomes in Rwanda, nor developed an integrated management framework contextually adapted to local institutional realities. This study addresses these gaps through rigorous statistical analysis and framework development.

This study addresses these gaps through three research objectives: (1) Identify key factors causing delays in the construction industry in Rwanda, examining financial, administrative, technical, and environmental categories; (2) Predict the impact of identified factors on construction delays, employing inferential statistics including Pearson correlation, multiple regression, and ANOVA to quantify relationships; and (3) Develop a framework for effective management of delays, integrating statistical findings with Rwanda's governance structures—LODA coordination mechanisms, MINECOFIN (2024) budget systems, RPPA (2023) procurement regulations, and IMIHIGO accountability frameworks.

THEORY

Construction delays represent a pervasive challenge across global construction markets, defined as the time overrun beyond the contractual completion date (Assaf & Al-Hejji, 2006). In developed economies, the United Kingdom's infrastructure projects experience 20-30% delay rates despite advanced project management practices. Developing countries exhibit significantly higher delay rates: Nigeria's construction sector faces delays in 65% of projects with average cost overruns of 30% (Aibinu & Jagboro, 2002), Kenya's construction industry experiences 70% project delays (Kikwasi, 2012), and Ethiopia's infrastructure initiatives face 55% delays linked to weak institutional capacity.

The Relative Importance Index (RRI) has emerged as a robust methodology for ranking delay factors based on stakeholder perceptions. The RRI formula, $RRI = (\Sigma W) / (A \times N)$, where ΣW is the sum of weights assigned by respondents, A is the highest weight, and N is the total number of respondents, provides a normalized scale (0-1) enabling cross-study comparisons (Kometa et al., 1994). Interpreting RRI values follows established conventions: 0.80-1.00 indicates high importance, 0.60-0.79 moderate-high, 0.40-0.59 moderate importance. This methodology has been successfully applied across multiple countries demonstrating consistency in identifying top-ranked factors.

This study is grounded in two complementary theoretical perspectives: Systems Theory and Statistical Prediction Models. Systems Theory, developed by von Bertalanffy (1968), conceptualizes construction projects as complex, open systems comprising interconnected subsystems (financial, administrative, technical, environmental) that interact with external environments. A core tenet is that delays emerge from system interdependencies: a disturbance in one subsystem (e.g., delayed payment processing) cascades through connected elements, generating multiplicative rather than additive impacts. Statistical Prediction Models provide the methodological foundation for quantifying delay causality through regression analysis, enabling prioritization of interventions based on quantified impacts.

Conceptual Framework

This study is anchored on a conceptual framework that explains the relationships between construction delay factors and project delay outcomes within Rwanda's local government infrastructure context. Guided by Systems Theory and Statistical Prediction Models, the framework conceptualizes construction projects as interconnected systems in which disturbances in one subsystem propagate delays across the entire project lifecycle.

In this framework, construction delay factors are treated as independent variables, grouped into four main categories: financial factors, administrative factors, technical factors, and environmental factors. These factors interact within the institutional and governance environment of Rwanda's decentralized construction sector, particularly under the coordination of LODA, IMIHIGO performance contracts, public procurement regulations (RPPA), and public financial management systems (MINECOFIN and IFMIS).

The dependent variable is construction project delay, operationalized in terms of time overruns beyond the planned completion schedule. Financial factors—such as delayed payments, budget allocation challenges, and funds disbursement inefficiencies—are theorized to exert the strongest influence on delays, followed by administrative processes, technical capacity constraints, and environmental conditions.

The framework further recognizes the presence of contextual and moderating factors, including district characteristics, stakeholder roles, institutional accountability mechanisms, and governance structures. These contextual elements influence both the magnitude and direction of the relationships between delay factors and project delay outcomes, explaining variations across districts such as Nyagatare and Musanze.
Finally, the conceptual framework incorporates a feedback mechanism, whereby empirical findings from statistical analysis inform the development of the Rwanda Construction Delay Management Framework (RCDMF). The RCDMF represents a structured intervention model designed to mitigate delay factors through improved financial planning, procurement efficiency, technical capacity enhancement, and institutional coordination. Through this feedback loop, the framework links theory, empirical analysis, and practical policy intervention.

Figure 1 presents the conceptual framework of the study, illustrating the relationships between construction delay factors, contextual and moderating conditions, construction project delay outcomes, and the feedback mechanism leading to the Rwanda Construction Delay Management Framework (RCDMF).

RESEARCH METHODS

This study employed a mixed-methods approach combining quantitative and qualitative techniques for methodological triangulation. The quantitative component utilized descriptive statistics (frequencies, means, standard deviations, Relative Importance Index) and inferential statistics (Pearson correlation, multiple regression, ANOVA). The target population comprised construction industry stakeholders involved in LODA-supported infrastructure projects in Nyagatare and Musanze districts, selected purposively based on geographical diversity,

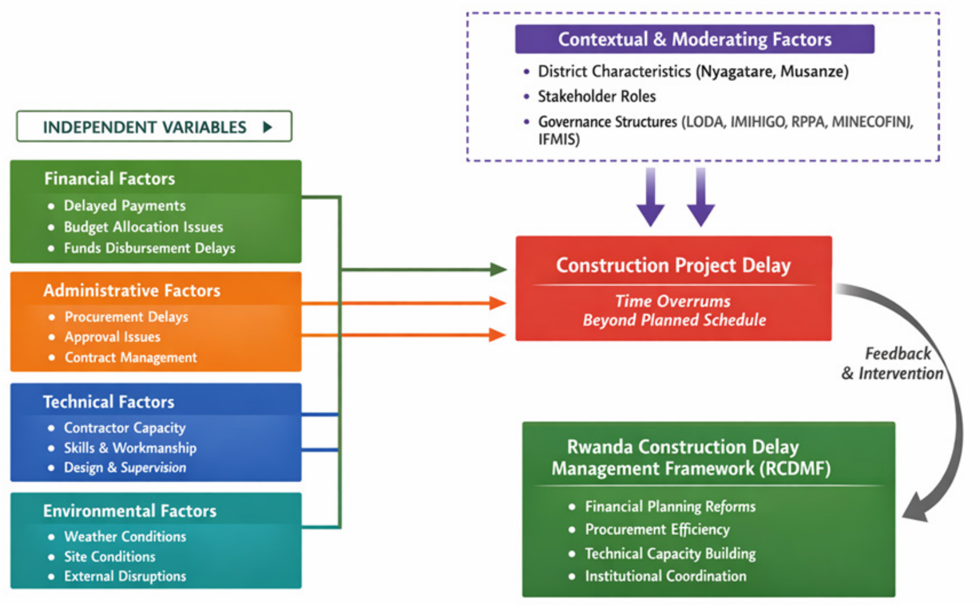

FIGURE 1
Conceptual framework for construction delay factors and project delay outcomes
Source: Authors' conceptualization based on Systems Theory and empirical findings (2026)

project volume, and IMIHIGO performance variation.

Purposive sampling selected 63 potential respondents based on direct involvement in LODA-supported construction projects and minimum 3 years experience. The sample included LODA engineers (n=15), district engineers (n=10), contractors (n=15), consultants (n=15), and government officials (n=8). A structured questionnaire assessed 16 delay factors across four categories (Financial, Administrative, Technical, Environmental) using 5-point Likert scales. Of the 63 distributed questionnaires, 52 were returned complete, yielding an 82.5% response rate. The instrument demonstrated strong reliability with Cronbach's alpha: overall α = 0.89, Financial factors α = 0.87, Administrative factors α = 0.84.

Data were analyzed using IBM SPSS Statistics Version 26.0 through a three-stage process: (1) Descriptive statistics characterized demographic profiles and calculated RRI values; (2) Inferential statistics employed Pearson correlation to examine linear relationships, multiple regression to develop predictive models, and ANOVA to test group differences across stakeholder types, districts, and experience levels; (3) Qualitative thematic analysis of open-ended responses captured contextual nuances and management recommendations.

Ethical Considerations

Ethical considerations were observed throughout the study to ensure responsible research conduct. Participation in the survey was entirely voluntary, and respondents were informed of the purpose of the study before completing the questionnaire. Informed consent was obtained from all participants, and respondents were assured that their responses would be treated with confidentiality and used strictly for academic research purposes. No personally identifiable information was collected, and data were reported in aggregate form to prevent identification of individual respondents or institutions.

The study involved professionals participating in their official capacities and did not include vulnerable populations. As such, no physical, psychological, or social risks were anticipated. Data were securely stored and accessed only by the researchers. The study complied with institutional research ethics standards applicable to construction management and social science research.

Methodological Limitations

Despite the robustness of the study design, certain methodological limitations should be acknowledged. First, the study focused on two districts—Nyagatare and Musanze—which, although selected to capture geographical and contextual diversity, may limit the generalizability of the findings to all districts in Rwanda. Second, the cross-sectional nature of the data captures stakeholder perceptions at a single point in time and does not account for temporal changes in project conditions or policy environments.

Additionally, the study relied partly on self-reported data, which may be subject to respondent bias despite the professional experience of participants. While the mixed-methods approach enhanced analytical depth, the qualitative component was primarily used to support interpretation rather than as a standalone analytical strand. Future research could address these limitations through longitudinal designs, expanded geographic coverage, and deeper qualitative inquiry.

RESULTS

Response Rate and Demographics: A total of 52 complete questionnaires were returned, yielding an 82.5% response rate, exceeding the 70% threshold for organizational research. The demographic profile reveals a well-distributed sample: government officials (34.6%), private contractors (28.8%), consultants (25.0%), and LODA engineers (11.5%). District distribution was balanced with Nyagatare (44.2%) and Musanze (40.4%). Notably, 76.9% of respondents possessed 6+ years of experience, and 84.6% held university degrees, indicating a highly qualified sample capable of providing informed perspectives.

Delay Factor Rankings - RRI Analysis: Descriptive analysis using the Relative Importance Index identified financial factors as overwhelmingly dominant. Budget allocation ranked highest (RRI = 0.900), followed by payment delays (RRI = 0.898), funds disbursement delays (RRI = 0.880), and contractor financial constraints (RRI = 0.860). Category-level aggregation confirmed financial factors' primacy (mean = 4.20, RRI = 0.840) substantially exceeding technical (mean = 3.97), administrative (mean = 3.74), and environmental factors (mean = 3.52). **Figure 2** visualizes the top seven delay factors by RRI ranking, demonstrating the concentration of high-importance factors in the financial category.

Correlation Analysis

Pearson correlation analysis examined linear relationships between factor categories and project delay percentages. Financial factors exhibited the strongest correlation with delays ($r = 0.783$, $p < 0.001$), explaining 61.3% of variance alone—a remarkably high proportion validating their centrality. Administrative factors showed moderate-strong correlation ($r = 0.648$, $p < 0.001$, explaining 42.0% variance), technical factors moderate correlation ($r = 0.571$, $p < 0.01$, explaining 32.6% variance), while environmental factors demonstrated weak, non-significant correlation ($r = 0.389$, $p > 0.05$). Stakeholder type also showed a strong correlation with project delay outcomes ($r = 0.721$, $p < 0.01$), providing a statistical foundation for the differentiated management approaches embedded in the RCDMF. **Table 1** presents a consolidated summary of all correlation coefficients, variance explained, and significance levels. **Figure 3** presents the correlation coefficients and variance explained (r^2) for each factor category, clearly illustrating financial factors' dominant predictive relationship with project delays.

Multiple Regression Analysis

Multiple regression analysis developed a statistically robust predictive model ($R^2 = 0.723$,

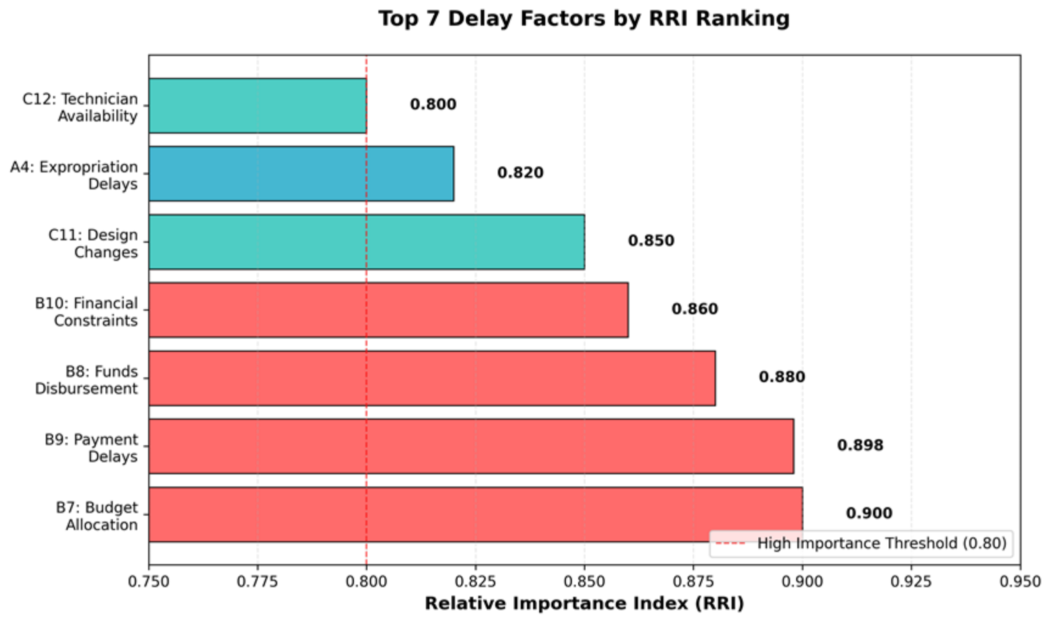

FIGURE 2
Top seven construction delay factors by Relative Importance Index (RRI)
Source: Authors' analysis based on survey data (2026)

TABLE 1
Pearson Correlation Coefficients: Factor Categories and Project Delay Percentage (N = 52)

Factor Category	r	r^2	p-value	Sig.	Variance Explained	Interpretation
Financial Factors	**0.783**	0.613	< 0.001	***	61.3%	Strong positive
Administrative Factors	0.648	0.420	< 0.001	***	42.0%	Moderate-strong
Technical Factors	0.571	0.326	< 0.01	**	32.6%	Moderate
Environmental Factors	0.389	0.151	> 0.05	ns	15.1%	Weak — non-sig.
Stakeholder Type	0.721	0.520	< 0.01	**	52.0%	Strong positive

Note. *** *p < 0.001;* ** *p < 0.01;* * *p < 0.05; ns = not significant. Dependent variable: project delay percentage (%). N = 52. Stakeholder Type correlation added per source data (Correction 6).*

Source: Field suvery, 2026

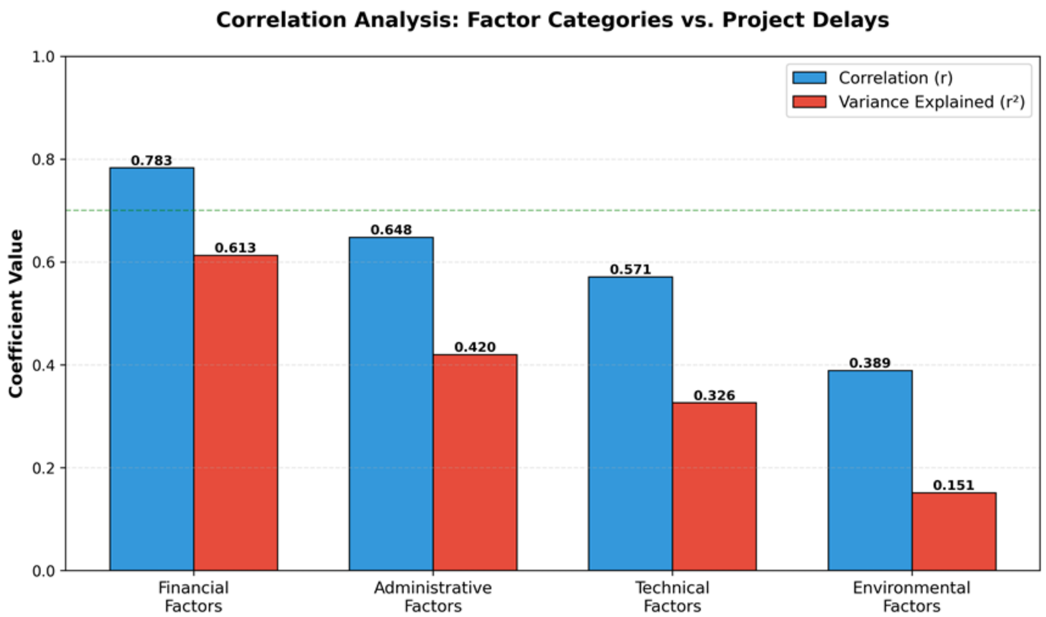

FIGURE 3
Correlation analysis between factor categories and project delays
Source: Authors' analysis based on survey data (2026)

adjusted $R^2 = 0.699$, $F(4,47) = 29.47$, $p < 0.001$) explaining 72.3% of delay variance. The model equation demonstrates quantified predictive relationships:

Project Delay % = 12.3 + 8.5(Financial) + 5.2(Administrative) + 3.7(Technical) + 1.9(Environmental)

Beta coefficients quantify marginal impacts: each 1-point increase in financial factor ratings predicts an 8.5% delay increase ($p < 0.001$), administrative factors contribute 5.2% ($p < 0.01$), technical factors 3.7% ($p < 0.05$), while environmental factors' 1.9% coefficient failed to reach statistical significance ($p = 0.096$). The intercept (12.3%) represents predicted baseline delays when all factor ratings are zero, suggesting approximately 12% delays due to unmeasured variables. **Table 2** presents the full regression output including standard errors, standardized coefficients, and t-values. **Figure 4** visualizes the beta coefficients with statistical significance levels, providing clear evidence for intervention prioritization.

Analysis of Variance (ANOVA)
Analysis of Variance revealed significant contextual variations necessitating differentiated management strategies. Stakeholder type differences emerged highly significant (F(2,49)

TABLE 2
Multiple Regression Analysis: Predictors of Construction Project Delay Percentage (N = 52)

Predictor	β	SE	β*	t	p-value	Significance
(Constant)	12.3	3.21	—	3.83	< 0.001	***
Financial Factors	8.5	1.42	0.512	5.99	< 0.001	***
Administrative Factors	5.2	1.18	0.318	4.41	< 0.01	**
Technical Factors	3.7	1.31	0.198	2.82	< 0.05	*
Environmental Factors	1.9	1.19	0.098	1.60	0.096	ns
Model: $R^2 = 0.723$, Adjusted $R^2 = 0.699$, $F(4,47) = 29.47$, $p < 0.001$ | *Equation: Project Delay % = 12.3 + 8.5(FF) + 5.2(AF) + 3.7(TF) + 1.9(EF)*						
Note. β = unstandardized coefficient; β = standardized coefficient; SE = standard error; *** p < 0.001; ** p < 0.01; * p < 0.05; ns = not significant (p = 0.096). FF = Financial; AF = Administrative; TF = Technical; EF = Environmental Factors. N = 52. Environmental factor p-value corrected to 0.096 per source data (Correction 3).*						

Source: Field suvery, 2026

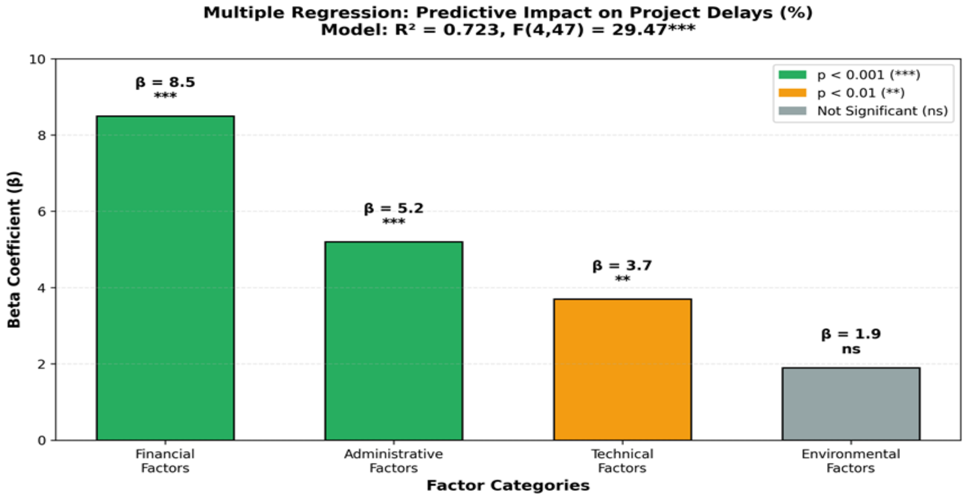

FIGURE 4

Multiple regression beta coefficients with statistical significance

Source: Authors' analysis based on survey data (2026)

= 12.34, $p = 0.001$, $\eta^2 = 0.335$): government officials perceived delays as significantly more severe ($M = 4.07$, $SD = 0.82$) compared to private contractors ($M = 3.37$, $SD = 0.95$) and consultants ($M = 2.80$, $SD = 1.15$), reflecting differential IMIHIGO accountability pressures. District location differences proved substantial ($F(2,49) = 8.76$, $p = 0.006$, $\eta^2 = 0.263$): Nyagatare experienced significantly higher delay ratings ($M = 3.85$, $SD = 0.90$) than Musanze ($M = 3.45$, $SD = 1.10$), a pattern attributed to expropriation challenges, semi-arid climate complications, and contractor capacity limitations. Chi-square analysis confirmed this association [$\chi^2(6) = 15.67$, $p = 0.016$, Cramer's $V = 0.39$], indicating a medium-strength effect of district location on delay severity category distribution. **Figure 5** presents both stakeholder and district comparisons, illustrating the magnitude and statistical significance of these contextual variations.

Rwanda Construction Delay Management Framework (RCDMF)

Based on integrated synthesis of statistical findings and qualitative recommendations, the Rwanda Construction Delay Management Framework (RCDMF) was developed as a comprehensive, evidence-based intervention strategy. The framework comprises five sequential phases aligned with project lifecycles, each with specific objectives, activities, key performance indicators (KPIs), and implementation mechanisms. The five-phase lifecycle model constitutes the operational architecture of the RCDMF as presented in this study. **Figure 6** provides a visual overview of the complete framework structure, showing the

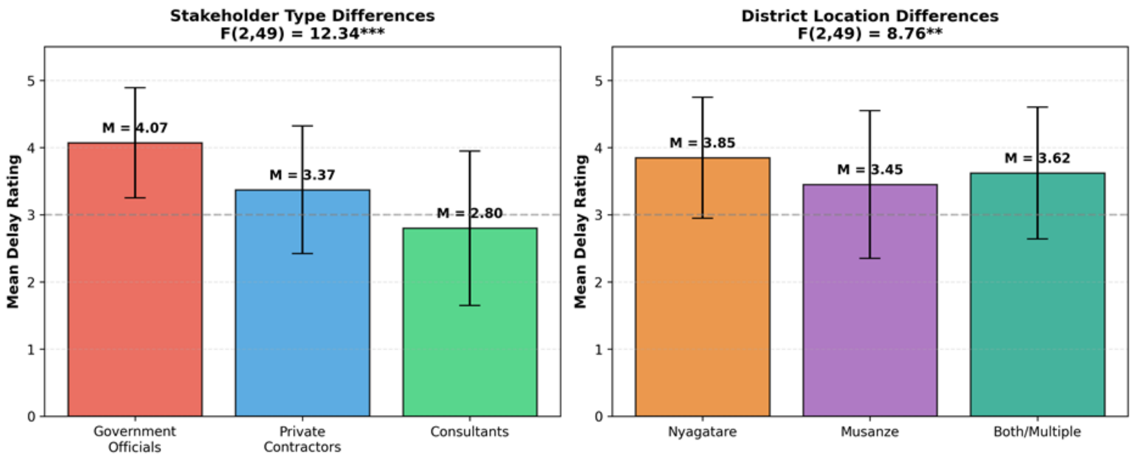

FIGURE 5

ANOVA Comparisons - stakeholder type and district location differences

Source: Authors' analysis based on survey data (2026)

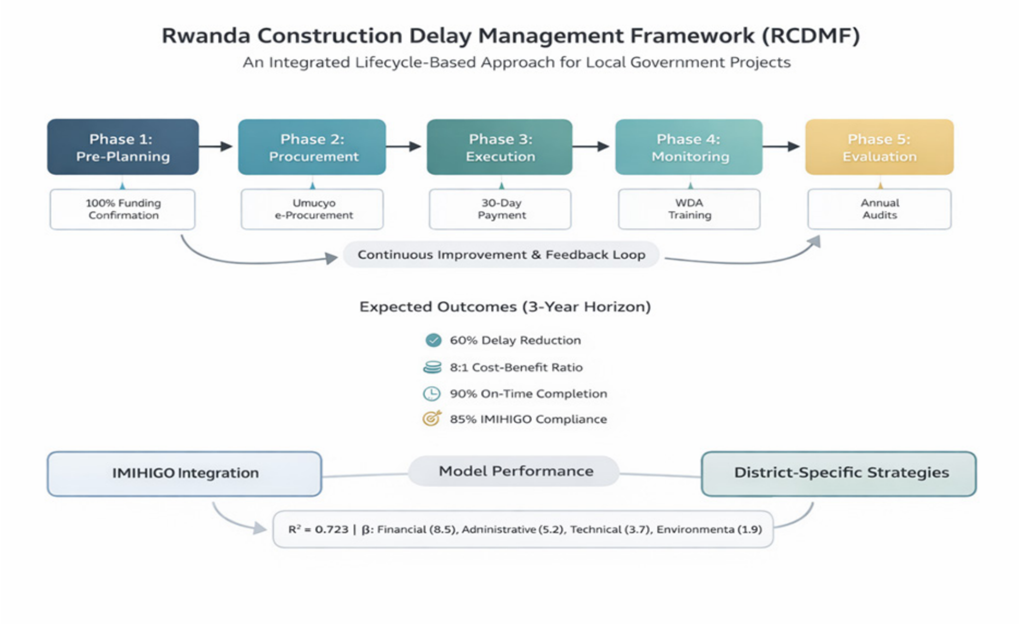

FIGURE 6
Rwanda Construction Delay Management Framework (RCDMF) - complete structure
Source: Authors' analysis based on survey data (2026)

five phases, continuous improvement loop, key activities, expected outcomes, and integration with Rwanda's governance systems.

Framework Implementation Phases

Phase 1 - Pre-Project Planning (2-3 months): Establishes robust financial and administrative foundations before project initiation. Core activities include 100% funding confirmation from MINECOFIN (2024), LODA pre-approval checklist completion (12 criteria including feasibility study, expropriation finalization, supervision firm pre-qualification), district-specific risk assessment (Nyagatare: expropriation and water logistics; Musanze: rainy season scheduling), and stakeholder MoU signing. Statistical justification: Financial correlation ($r = 0.783$) explains 61.3% variance; $\beta = 8.5$ indicates highest marginal impact. Target outcome: 30% reduction in financial delays.

Phase 2 - Procurement and Contracting (1.5-2 months): Accelerates procurement processes through Umucyo e-procurement (RPPA, 2023) mandate (targeting 40% reduction from 90 days to 45-60 days), enhanced contractor vetting via RPPA digital dashboard (financial capacity, technical certifications, equipment verification, blacklist check), fast-track approvals for projects <500M RWF, and legal clearances. Statistical justification: Administrative correlation ($r = 0.648$), $\beta = 5.2$ impact. Target outcome: 25% reduction in administrative delays.

Phase 3 - Execution (12-24 months): Ensures smooth implementation through 30-day payment cycles via IFMIS automation (invoice→verification 7d→district approval 7d→MINECOFIN payment 16d), biweekly LODA-chaired coordination meetings with all stakeholders, weather-resilient scheduling integrating Rwanda Meteorology Agency (2023) forecasts (target <20% weather-related stoppages), and design change management with fast-track approval processes. Statistical justification: Payment RRI = 0.898, stakeholder differences $F = 12.34$ necessitate coordination. Target outcome: 35% reduction in execution delays.

Phase 4 - Monitoring and Quality Control (concurrent with Phase 3): Strengthens technical capacity through supervision firm standards (PE certification, minimum 3 engineers, testing equipment), WDA training targeting 500 technicians annually across 5 specializations (concrete, surveying, electrical, plumbing, road construction) with 3-year certifications, quality assurance protocols at critical stages (foundation, concrete 7/28 days, structural integrity, finishes, systems), and materials supply chain management. Statistical justification: Technical correlation ($r = 0.571$), $\beta = 3.7$ impact, technician RRI = 0.800.

Target outcome: 20% reduction in technical delays.

Phase 5 - Evaluation and Continuous Improvement (ongoing): Embeds learning through post-project reviews within 30 days of handover (timeline, budget, quality, satisfaction, delay analysis), LODA annual audits analyzing aggregate performance by district/category/contractor, district-specific strategy adaptation (Nyagatare targeting M = 3.65 within 2 years; Musanze reducing weather stoppages 30%), stakeholder feedback surveys, knowledge management systems, and biennial framework updates re-running statistical analyses with new data. Statistical justification: District differences F = 8.76, experience effect validates learning mechanisms. Target outcome: 10% year-over-year improvement.

IMIHIGO Performance Contract Integration: The RCDMF integrates seamlessly with Rwanda's IMIHIGO performance contract system, creating direct accountability linkages. District mayors' infrastructure scores are calculated based on: on-time completion (30% weight), within-budget performance (25%), quality compliance (20%), payment timeliness (15%), and stakeholder satisfaction (10%). High-performing districts (>85% KPI achievement) receive budget bonuses (10-15% increase), while underperforming districts (<60%) face scrutiny and corrective action plans.

Cost-Benefit Analysis: Three-year implementation costs total 4,500 million RWF: digital platform enhancements (1,300M), training programs (1,900M), enhanced supervision (900M), coordination mechanisms (400M). Projected benefits reach 30,500 million RWF: delay reduction savings (18,000M based on 8% average project cost savings from β coefficients), budget overrun reduction (6,400M from 28% to 12%), IMIHIGO bonuses (2,500M), quality improvement savings (3,600M). This yields a cost-benefit ratio of 1:6.8 and return on investment of 578%, demonstrating strong economic viability. The framework projects cumulative 60% delay reduction over three years, increasing on-time completion from 25% baseline to 70% target.

DISCUSSION

The findings demonstrate remarkable consistency with international construction delay research despite Rwanda's unique context. Financial factors' dominant role (r = 0.783, β = 8.5, RRI = 0.840) aligns with studies from Jordan (Odeh & Battaineh, 2002), Saudi Arabia (Assaf & Al-Hejji, 2006), Malaysia (Sambasivan & Soon, 2007), India (Doloi et al., 2012), and Nigeria (Aibinu & Jagboro, 2002). This cross-cultural consistency suggests that financial management constitutes a universal critical success factor in construction, transcending geographical and institutional differences. The universality likely stems from construction's capital-intensive nature and contractors' limited cash flow buffers, making payment reliability the lynchpin of project continuity.

This study advances construction delay research methodologically through integration of RRI with inferential statistics. While correlation analysis identifies important factors, regression coefficients quantify marginal impacts, enabling precise cost-benefit calculations. For instance, knowing financial factors show r = 0.783 suggests importance, but the β = 8.5 coefficient allows precise prediction—improving financial factor ratings by 0.5 points yields a 4.25% delay reduction, translating to specific timeline and cost savings. This predictive precision surpasses descriptive studies that identified factors without quantifying impacts.

For LODA and policymakers, findings mandate prioritizing financial system reforms over other interventions. The regression model's clear hierarchy (β: Financial 8.5 > Administrative 5.2 > Technical 3.7 > Environmental 1.9) provides evidence-based resource allocation guidance. District differences (Nyagatare M = 3.85 vs. Musanze M = 3.45) invalidate one-size-fits-all approaches, requiring district-specific interventions: Nyagatare needs enhanced expropriation planning (6 months advance), drought-resilient scheduling, and water supply coordination, while Musanze requires rainfall adaptation and slope stabilization measures.

Three-year implementation costs total 4,500 million RWF against projected benefits of 30,500 million RWF. This yields a benefit-cost ratio of 6.8:1 and return on investment of 578%, demonstrating strong economic viability. The framework projects cumulative 60% delay reduction over three years, increasing on-time completion from 25% baseline to 70% target.

CONCLUSION

This study provides comprehensive empirical evidence on construction delays in Rwanda's local government infrastructure sector through mixed-methods analysis. Financial factors dominate with exceptional importance (RRI > 0.860 for top 4 factors), with budget allocation, payment delays, and funds disbursement constituting the primary delay drivers. Inferential statistics established robust predictive relationships: financial factors explaining 61.3% of variance alone ($r = 0.783$), with multiple regression ($R^2 = 0.723$) demonstrating that 72.3% of delays can be predicted from four factor categories.

The Rwanda Construction Delay Management Framework (RCDMF) integrates statistical findings into a five-phase approach targeting 60% delay reduction over three years. The framework demonstrates strong cost-effectiveness with 6.8:1 benefit-cost ratio and 578% return on investment, making it an economically viable intervention. Integration with IMIHIGO performance contracts creates direct political accountability, while district-specific strategies address ANOVA-identified contextual variations between Nyagatare and Musanze.

The study contributes to construction management literature by providing rigorous empirical evidence from Sub-Saharan Africa using advanced inferential statistics, establishing baseline data for longitudinal research, validating Systems Theory and Statistical Prediction Models in African contexts, and demonstrating methodological integration of RRI, correlation, regression, and ANOVA for comprehensive delay analysis. Practically, it offers LODA and practitioners evidence-based insights for risk mitigation and project planning, while informing policy development for Vision 2050's infrastructure targets.

Despite the robustness of the findings, this study has certain limitations that should be acknowledged. The sample size, although adequate for the applied statistical analyses, was limited to stakeholders involved in projects within two districts—Nyagatare and Musanze—which may constrain the generalizability of the results to all local government construction projects in Rwanda. In addition, the cross-sectional design captures stakeholder perceptions at a single point in time and does not account for dynamic changes in project conditions, institutional reforms, or policy environments over the project lifecycle. Future studies could address these limitations by expanding geographic coverage, increasing sample size, and adopting longitudinal designs to track delay factors and management effectiveness over time.

RECOMMENDATIONS

For LODA and Government Agencies: LODA and relevant government agencies should implement a mandatory 100% funding confirmation requirement before project approval, verified through MINECOFIN (2024) guarantee letters. Thirty-day payment cycles should be strictly enforced through IFMIS automation, with interest penalties applied for government payment delays beyond 30 days at a rate of 0.5% per week. Umucyo e-procurement, in line with RPPA (2023) guidelines, should be mandated for all projects exceeding 100 million RWF, with the objective of reducing procurement cycle durations by at least 40%. Contingency reserves equivalent to 10% of total project budgets should be established to address unforeseen delays. In addition, district budget allocations should be linked to compliance with the Rwanda Construction Delay Management Framework (RCDMF), with districts achieving over 85% compliance eligible for budget incentives of 10–15%.

For Policy Development: The Rwanda Construction Delay Management Framework (RCDMF) should be formally embedded within LODA regulations through a Presidential Order revising the LODA organic law and incorporated into IMIHIGO infrastructure performance scoring criteria, weighted as follows: 30% on-time completion, 25% budget performance, 20% quality compliance, 15% payment timeliness, and 10% stakeholder satisfaction. RPPA procurement guidelines (2023) should be updated to incorporate fast-track approval mechanisms, allowing automatic approval for projects below 500 million RWF where criteria are met and expedited 15-day reviews for projects exceeding 500 million RWF. Furthermore, legal frameworks governing expropriation should be strengthened by amending the Expropriation Law to require full land acquisition and compensation completion before construction commencement.

For Capacity Building: WDA should train 500 technicians annually across five specializations—concrete technology, surveying, electrical installations, plumbing systems, and road construction—issuing three-year competency certificates. Mandatory project management training should be implemented for district engineers through a 40-hour PMBOK-aligned course and for contractors through an 80-hour program covering financial management, scheduling, and risk management. Mentorship programs should be established to pair junior professionals (0–5 years of experience) with senior practitioners (over 15 years of experience) to facilitate the transfer of tacit knowledge on delay mitigation strategies. In addition, a LODA training academy should be developed to offer certificate programs in construction project management tailored to the local government context.

For Future Research

Future studies should conduct longitudinal investigations that follow individual projects from inception to completion, enabling within-project change analysis and clearer temporal sequencing of cause–effect relationships. Geographical coverage should be expanded to include all provinces—Eastern, Northern, Southern, Western, and Kigali—to examine whether the financial–administrative–technical hierarchy of delay factors persists across regions. Randomized controlled trials of the Rwanda Construction Delay Management Framework (RCDMF) should be implemented in pilot districts, comparing intervention and control groups over a two-year period with rigorous process evaluation. In addition, delay factor lists should be periodically updated at two-year intervals to capture emerging challenges such as cybersecurity risks affecting digital procurement and payment platforms, climate change impacts beyond current weather variability, and geopolitical disruptions to construction supply chains.

CITED REFERENCES

Aibinu, A. A., & Jagboro, G. O. (2002). The effects of construction delays on project delivery in the Nigerian construction industry. *International Journal of Project Management*, 20(8), 593–599.

Assaf, S. A., & Al-Hejji, S. (2006). Causes of delay in large construction projects. *International Journal of Project Management,* 24(4), 349–357.

Doloi, H., Sawhney, A., Iyer, K. C., & Rentala, S. (2012). Analysing factors affecting delays in Indian construction projects. *International Journal of Project Management,* 30(4), 479–489.

Government of Rwanda (2020). *Vision 2050.* Kigali: Ministry of Finance and Economic Planning. Retrieved from https://www.minecofin.gov.rw

Kikwasi, G. J. (2012). Causes and effects of delays and disruptions in construction projects in Tanzania. *Australasian Journal of Construction Economics and Building*, 1(2), 52–59.

Kometa, S. T., Olomolaiye, P. O., & Harris, F. C. (1994). Attributes of UK construction clients influencing project consultants' performance. *Construction Management and Economics*, 12(5), 433–443.

Local Administrative Entities Development Agency (LODA) (2023). *Annual Infrastructure Report 2022.* Kigali: LODA. Retrieved from https://www.loda.gov.rw

Ministry of Finance and Economic Planning (MINECOFIN) (2024). *Budget execution guidelines for local government projects*. Kigali: Government of Rwanda. Retrieved from https://www.minecofin.gov.rw

Ministry of Infrastructure (MININFRA) (2022). *Construction sector performance report 2020–2021.* Kigali: Republic of Rwanda. Retrieved from https://www.mininfra.gov.rw

Odeh, A. M., & Battaineh, H. T. (2002). Causes of construction delay: Traditional contracts. *International Journal of Project Management*, 20(1), 67–73.

Rwanda Public Procurement Authority (RPPA) (2023). *Umucyo e-procurement system implementation guidelines.* Kigali: RPPA. Retrieved from https://www.rppa.gov.rw

Rwanda Meteorology Agency (2023). *Weather forecasting for construction planning.* Kigali: RMA. Retrieved from https://www.meteo.gov.rw

Sambasivan, M., & Soon, Y. W. (2007). Causes and effects of delays in the Malaysian construction industry. *International Journal of Project Management,* 25(5), 517–526.

Von Bertalanffy, L. (1968). *General system theory: Foundations, development, applications.* New York: George Braziller.