

Cost Control Practices and Project Performance in Public Construction Projects in Kigali City: Evidence from the Kigali Infrastructure Project

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Abstract: Public construction projects in developing economies frequently suffer from cost overruns and delays due to fragmented financial governance and weak resource control. This study investigated the effect of cost control practices — cash flow monitoring, cost budgeting, cost estimation, and procurement planning — on project performance in the Kigali Infrastructure Project (KIP). Adopting a cross-sectional, correlational mixed-methods design, the study targeted 357 construction professionals from Nyarutarama Property Developers, selecting 189 respondents via stratified random sampling; questionnaires and interviews achieved a response rate of 96.3% (n = 180). Data were analysed using descriptive statistics, Pearson correlation, and multiple regression. Combined cost control practices significantly and positively predicted project performance, explaining 85.2% of the variance in outcomes ($R^2 = 0.852$). Cash flow monitoring was the strongest positive predictor ($\beta = 0.769$, $p < .001$), followed by procurement planning ($\beta = 0.145$, $p = .010$) and cost budgeting ($\beta = 0.129$, $p = .018$); cost estimation showed a small negative partial coefficient, consistent with a statistical suppression effect rather than a substantive adverse relationship. The study concludes that continuous financial surveillance and strategic supply-chain management are the primary drivers of project success for KIP, and recommends that practitioners institutionalise integrated digital systems for real-time cash flow tracking, while policymakers mandate standardised digital procurement frameworks and centralised historical cost databases.

Keywords: Cost Control Practices; Cash Flow Monitoring; Cost Budgeting; Cost Estimation; Procurement Planning; Project Performance; Rwanda.

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I. INTRODUCTION

Public construction projects in developing economies frequently suffer from cost overruns, schedule delays, and inefficient resource utilisation arising from fragmented financial governance and weak cost control systems. Effective cost control, encompassing cash flow monitoring, cost budgeting, cost estimation, and procurement planning, is widely recognised as a determinant of construction project success, yet the specific mechanisms through which these practices jointly shape performance in large, publicly funded infrastructure projects in East Africa remain empirically underexplored.

Rwanda's rapid urbanisation has driven substantial investment in public infrastructure, including large-scale urban road and utility programmes such as the Kigali Infrastructure Project (KIP), implemented by Nyarutarama Property Developers and comprising approximately 215

kilometres of asphalt road construction in Kigali City. Public infrastructure projects of this scale involve complex, multi-stakeholder financial governance, where the government or client acts as principal and the implementing contractor as agent, creating conditions in which weak cash flow oversight, unrealistic budgets, inaccurate cost estimates, or poorly sequenced procurement can rapidly translate into cost overruns and delays.

While cost control practices have been extensively studied individually, in isolation from one another, and largely outside the East African public infrastructure context, comprehensive, multi-variable empirical evidence on how cash flow monitoring, cost budgeting, cost estimation, and procurement planning jointly influence project performance within a single large Rwandan public infrastructure project remains limited. This study addresses that gap by investigating the effect of cost control practices on project performance in the Kigali Infrastructure Project. The specific

objectives were to determine the effect of (i) cash flow monitoring, (ii) cost budgeting, (iii) cost estimation, and (iv) procurement planning on the performance of public construction projects in Kigali, Rwanda.

II. LITERATURE REVIEW

➤ *Conceptual Review*

Cash flow monitoring refers to the continuous tracking, recording, and verification of project fund inflows and outflows to ensure that disbursements align with physical progress and approved financial plans. Cost budgeting involves translating project scope into a detailed allocation of funds across activities and cost categories, establishing the financial baseline against which actual expenditure is tracked and variances identified. Cost estimation is the process of predicting the resources and financial requirements needed to complete a project, typically informed by historical data, quantity take-offs, and market pricing, and underpins realistic budget preparation and funding decisions. Procurement planning encompasses the identification of project needs, selection of procurement methods, and scheduling of acquisition processes to ensure the timely, cost-effective, and compliant delivery of goods, services, and works. Project performance, the dependent construct, is operationalised through cost adherence, schedule compliance, quality of work, and stakeholder satisfaction.

➤ *Theoretical Review*

This study is anchored in three complementary theories. Agency Theory [1,2] explains the contractual relationship between principals (government or project owners) and agents (contractors, consultants, and project managers), each assumed to act in their own self-interest under conditions of information asymmetry. Agency Theory provides the conceptual basis for cash flow monitoring and cost budgeting: continuous financial tracking and an approved budget baseline function as oversight mechanisms that reduce opportunistic behaviour, enhance transparency, and align contractor conduct with the principal's financial objectives, thereby mitigating agency costs. Transaction Cost Economics (TCE) Theory [3] holds that economic transactions carry inherent costs — search, negotiation, and enforcement — and that organisations design governance structures to minimise these costs under conditions of uncertainty, bounded rationality, and opportunism. TCE underpins procurement planning and cost estimation in this study: structured procurement scheduling and competitive vendor selection reduce search and negotiation costs, while accurate ex-ante cost estimation reduces the transaction costs associated with contract disputes and renegotiation. Cost Management Theory, tracing to the scientific management tradition and subsequently developed through target and responsibility cost accounting, explains how structured cost planning, forecasting, and disciplined budgeting jointly contribute to efficient resource allocation and improved project performance, providing the theoretical foundation linking cost budgeting and cost estimation directly to performance outcomes.

➤ *Empirical Review and Research Gaps*

Empirical evidence linking cash flow monitoring to construction project performance is well established in Sub-Saharan African contexts, where irregular financial tracking and delayed reporting have been shown to precipitate budget overruns and contractor disputes, while systematic, real-time monitoring improves financial discipline and transparency [4,12]. Similarly, cost budgeting research indicates that a lack of thorough budget reviews and weak variance analysis are primary drivers of cost overruns and schedule delays in developing-country construction sectors, whereas detailed, well-structured budgeting frameworks improve cost adherence [5,14]. Accurate, historically informed cost estimation reduces the variance between planned and actual costs and mitigates the optimism bias that frequently underlies systematic cost underestimation in public works [6,7,13], though competitive, price-driven procurement and estimation practices can themselves introduce estimation distortions if not carefully governed [15]. Procurement planning research similarly demonstrates that inadequate scheduling and weak vendor selection processes lead to material shortages, cost escalation, and project delays, whereas structured, transparent procurement systems improve coordination and reduce transaction inefficiencies [8].

Within Rwanda specifically, studies confirm that project-level cost control significantly improves construction outcomes in Kigali [9], that cost and time overruns remain a persistent challenge in Kigali road construction projects [10], and that construction delays and cost overruns are a recurring feature of Kigali-based infrastructure delivery more broadly [16]. However, three specific gaps remain. Empirically, most Rwandan studies examine cost control as an undifferentiated construct or focus on a single practice in isolation, rather than modelling cash flow monitoring, cost budgeting, cost estimation, and procurement planning jointly within one analytical framework, and few extend this analysis to large-scale public infrastructure programmes specifically. Theoretically, prior studies rarely integrate Agency Theory and Transaction Cost Economics to explain both the internal financial-oversight and external contracting dimensions of cost control simultaneously. Methodologically, much of the existing Rwandan literature relies on descriptive statistics rather than the multivariate regression techniques recommended for isolating the unique contribution of each cost control practice once the others are held constant [17,18], and rarely triangulates perceptual survey data against objective project records. This study addresses these three gaps by applying multiple regression analysis, corroborated by qualitative interview evidence and secondary documentary triangulation, to the Kigali Infrastructure Project.

III. RESEARCH METHODOLOGY

A cross-sectional, correlational, mixed-methods design with a quantitative-dominant approach was adopted to examine the relationship between cost control practices and project performance in the Kigali Infrastructure Project (KIP), implemented by Nyarutarama Property Developers in Kigali City, Rwanda. The target population comprised 357 technical and managerial professionals directly involved in KIP

implementation, spanning road designers, surveyors, site engineers, quantity surveyors, geotechnical, electrical, structural, materials, and mechanical engineers, project managers, and quality control engineers. Using Yamane's formula for finite populations at a 5% margin of error, the

computed sample size was 189, allocated proportionately across professional strata using stratified random sampling (Table 1); 180 valid, usable questionnaires were returned, a response rate of 96.3%.

Table 1 Sampling Frame by Area of Operation

Area of Operation	Population	Sample Size
Road designers	28	15
Surveyors	32	17
Site engineers	45	24
Quantity surveyors	38	20
Geotechnical engineers	26	14
Electrical engineers	30	16
Structural engineers	34	18
Materials engineers	25	13
Mechanical engineers	22	12
Project managers	28	15
Quality control engineers	49	26
Total	357	189

Primary data were collected using a structured, five-point Likert-scale questionnaire, complemented by semi-structured interviews with key project personnel (Project Manager, Lead Quantity Surveyor, Senior Cost Engineer, Procurement Manager, and Project Director) for contextual corroboration, and a secondary data collection sheet capturing objective budget-variance and schedule-adherence

records. Content and construct validity were established through expert review and alignment of every item with the study's theoretical and conceptual framework. Internal consistency, assessed via Cronbach's Alpha following a pilot study of 19 respondents (10% of the sample), was high across all constructs (Table 2).

Table 2 Reliability of Research Instrument (Cronbach's Alpha)

Variable	Cronbach's α	Remark
Cash flow monitoring	0.826	Reliable
Cost budgeting	0.858	Reliable
Cost estimation	0.972	Reliable
Procurement planning	0.900	Reliable
Project Performance	0.885	Reliable

Data were analysed in SPSS (Statistical Package for the Social Sciences) using descriptive statistics, Pearson correlation, and multiple regression analysis, following conventional thresholds for effect-size and significance interpretation [11]. Post-estimation diagnostics confirmed all regression assumptions were satisfied: variance inflation factors ranged from 1.0 to 3.2 (well below the threshold of 10) indicating no multicollinearity concern; the Durbin-Watson statistic (2.078) indicated no first-order autocorrelation; the Shapiro-Wilk test ($p = .112$) and visual inspection confirmed approximately normal residuals; and the Breusch-Pagan test ($p = .245$) confirmed homoscedasticity. To mitigate common method variance given the single-respondent collection of predictor and outcome data, perceptual survey findings were triangulated against objective secondary project records and qualitative interview evidence. Ethical procedures included informed consent, voluntary participation, and confidentiality of responses throughout.

IV. RESULTS AND DISCUSSION

➤ Correlation Analysis

All four cost control practices were positively and significantly correlated with project performance at the 0.01 level (Table 3). Cash flow monitoring showed the strongest association ($r = .901$), followed by procurement planning ($r = .762$), cost budgeting ($r = .745$), and cost estimation ($r = .550$). Notable inter-predictor correlations, particularly between procurement planning and cost budgeting ($r = .828$), and between cash flow monitoring and both procurement planning ($r = .705$) and cost estimation ($r = .691$), indicate that these practices are implemented as an interconnected system rather than in isolation, and signalled the need for multicollinearity diagnostics within the subsequent regression analysis.

Table 3 Pearson Correlation Matrix (N = 180)

Variable	CFM	CB	CE	PP	PERF
Cash flow monitoring (CFM)	1				
Cost budgeting (CB)	.686**	1			
Cost estimation (CE)	.691**	.375**	1		
Procurement planning (PP)	.705**	.828**	.375**	1	
Project Performance (PERF)	.901**	.745**	.550**	.762**	1

** Correlation is Significant at the 0.01 Level (2-Tailed).

➤ Multiple Regression Analysis

A multiple regression model tested the combined effect of the four cost control practices on project performance. The model was highly significant and explained 85.2% of the variance in project performance ($R^2 = .852$, Adjusted $R^2 =$

.849; $F(4,175) = 252.420$, $p < .001$; Durbin-Watson = 2.078), confirming that the four practices, considered jointly, are strong predictors of performance in the Kigali Infrastructure Project (Tables 4–5).

Table 4 Multiple Regression Model Summary

Model	R	R ²	Adj. R ²	Std. Error	Durbin-Watson
1: CFM, CB, CE, PP	0.923	0.852	0.849	0.09521	2.078

Table 5 Combined ANOVA Results

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	9.152	4	2.288	252.420	.000
Residual	1.586	175	.009		
Total	10.738	179			

At the individual predictor level (Table 6), cash flow monitoring emerged as the dominant predictor ($B = .833$, $\beta = .769$, $p < .001$), followed by procurement planning ($B = .109$, $\beta = .145$, $p = .010$) and cost budgeting ($B = .082$, $\beta = .129$, p

$= .018$), all positive and statistically significant. Cost estimation, by contrast, showed a small but statistically significant negative partial coefficient ($B = -.068$, $\beta = -.084$, $p = .042$).

Table 6 Multiple Regression Coefficients

Predictor	B	Std. Error	Beta	t	Sig.
(Constant)	.218	.140		1.558	.121
Cash flow monitoring	.833	.060	.769	13.868	.000
Cost budgeting	.082	.034	.129	2.396	.018
Cost estimation	-.068	.033	-.084	-2.045	.042
Procurement planning	.109	.042	.145	2.608	.010

➤ The Cost-Estimation Suppression Effect

The negative partial coefficient for cost estimation contrasts with its strong, positive bivariate correlation with project performance ($r = .550$, $p < .001$) and with independent secondary documentary evidence showing a low average cost-estimation error ($< 5\%$) on the project. This pattern is characteristic of a statistical suppression effect: once cash flow monitoring, cost budgeting, and procurement planning — each highly correlated with cost estimation — are held constant, the unique variance remaining for cost estimation to explain becomes small and, in this sample, slightly negative. Qualitative interview evidence supports this interpretation rather than a substantive claim that accurate estimation harms performance: the Senior Cost Engineer explained that initial estimates and historical data are vital for baseline-setting and securing funding, but that realised performance during execution is driven predominantly by dynamic, real-time cash flow monitoring and bi-weekly variance analysis. Cost estimation is therefore best understood as a foundational, statistically suppressed prerequisite that enables execution-phase controls to function effectively, rather than as a practice whose accuracy is

inversely related to performance; this study makes no causal claim given its cross-sectional design.

➤ Qualitative Corroboration and Triangulation

Interview evidence from project personnel corroborated the quantitative findings. The Project Manager described weekly cash flow tracking integrated directly with site progress reporting to prevent liquidity bottlenecks and contractor idle time. The Lead Quantity Surveyor noted that, despite delays in consolidating sub-contractor invoices, cost budgeting was prepared from detailed Bills of Materials and subjected to a multi-tier internal and external approval process. The Senior Cost Engineer described bi-weekly budget reviews and the use of parametric estimating software and historical municipal data to improve estimation accuracy, with variance analysis functioning as an early-warning system. The Procurement Manager described procurement planning strictly synchronised with the master construction schedule, using transparent e-procurement vendor selection to eliminate material-shortage-driven delays. Perceptual survey data were further triangulated against objective secondary project records: budget-variance and schedule-

adherence records confirmed that KIP maintained cost and schedule performance consistent with the high perception scores reported for budget adherence (mean = 4.61) and timely completion (mean = 4.42), indicating that the strong statistical associations reported above reflect verifiable project realities rather than perceptual bias alone.

➤ Discussion

These findings are consistent with the theoretical foundations set out in Section II. The dominance of cash flow monitoring as a predictor supports Agency Theory's proposition that continuous financial oversight reduces information asymmetry between principals and agents and curtails opportunistic behaviour [1,2], while the positive, significant contribution of cost budgeting reinforces Cost Management Theory's emphasis on a disciplined financial baseline as a mechanism for early detection of deviations. The significant positive contribution of procurement planning is consistent with Transaction Cost Economics, under which structured procurement scheduling and transparent vendor selection reduce search, negotiation, and enforcement costs [3]. The suppression pattern observed for cost estimation does not undermine its theoretical relevance; rather, it illustrates that in a project with strong execution-phase financial controls already in place, the marginal explanatory contribution of the initial estimate is absorbed by those dynamic controls, a nuance existing Rwandan cost-control literature has not previously examined at this level of statistical detail.

V. CONCLUSION AND RECOMMENDATIONS

This study examined the effect of cost control practices — cash flow monitoring, cost budgeting, cost estimation, and procurement planning — on project performance in the Kigali Infrastructure Project. Cost control practices, considered jointly, have a statistically significant and substantial positive effect on project performance ($R^2 = .852$, $F(4,175) = 252.420$, $p < .001$). Cash flow monitoring is the dominant driver of performance, procurement planning and cost budgeting make significant secondary positive contributions, and cost estimation, while foundational for baseline-setting and shown to be highly accurate on this project, is statistically suppressed once dynamic execution-phase controls are accounted for. The study concludes that project performance in large public infrastructure projects is best secured through an integrated cost-control system in which financial monitoring, budgeting, estimation, and procurement operate together, corroborated in this case by strong convergence between perceptual, documentary, and qualitative evidence.

Practitioners should institutionalise integrated digital systems for real-time cash flow tracking linked to physical site progress, transition from static to continuous, variance-driven budget reviews, strengthen cost estimation through centralised historical cost databases and parametric modelling with adequate contingency allowances, and align procurement scheduling strictly with the master construction programme. Policymakers, including the Rwanda Public

Procurement Authority and the Ministry of Infrastructure, should mandate standardised digital procurement and financial reporting frameworks, maintain a centralised historical cost database to reduce optimism bias in public-project budgeting, and establish periodic independent audits of budget and procurement compliance. Future research should extend this analysis to other rapidly urbanising Rwandan centres, test the moderating role of macroeconomic factors such as inflation and exchange-rate volatility, and adopt longitudinal designs to track cost-control effectiveness from conceptualisation through post-completion.

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➤ Declaration of Competing Interest

- The author declares no conflict of interest.

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