JRIIE Journal of Research Innovation and Implications in Education
Center for Research Implications & Practice
Website: www.jriiejournal.com ISSN 2520-7504 (Online) Vol.10, Iss.4, 2026 (pp. 1557 - 1567)

Effect of Project Planning Practices on the Performance of Government Hydropower Project in Rwanda: A Case of Nyabarongo II Hydropower Plant Project

Bisabo Chance and Afolabi Luqman
University of Kigali
https://orcid.org/0009-0008-5590-4767
Email: chancebisabo@gmail.com

Abstract: *Despite Rwanda's strong policy commitment to infrastructure-led development and its regional reputation for disciplined public investment governance, government-backed projects consistently face implementation and operational challenges that are traceable to fragmented upstream planning practices. This study examined the effect of project planning practices on the performance of the Nyabarongo II Hydropower Plant Project in Rwanda. Despite national infrastructure investments, hydropower projects face delays and cost overruns linked to planning deficits. Anchored in Project Management and Systems Theories, a descriptive-explanatory quantitative design was employed. Using Yamane's formula, 176 participants were sampled from a population of 314, achieving a 96.3% response rate (n = 170). Data were collected using structured questionnaires. The instrument demonstrated high reliability, with Cronbach's alpha values ranging from 0.829 to 0.947. Quantitative data were analyzed using SPSS v27 through descriptive statistics, Pearson correlation, and multiple regression. Results indicated that scope planning ($\beta = .755$, $p < .001$), time planning ($\beta = .132$, $p = .020$), and risk planning ($\beta = .152$, $p = .011$) significantly and positively influenced project performance. However, cost planning was insignificant in the combined model ($\beta = -.083$, $p = .055$). The integrated model explained 84.8% of the variance in project performance ($R^2 = .848$, $F = 229.343$, $p < .001$). The study concludes that integrated scope, time, and risk planning are critical for government hydropower success. It recommends strengthening scope validation, realistic scheduling, and proactive risk registers, while integrating cost planning with other dimensions.*

Keywords: *Project Planning Practices, Scope Planning, Time Planning, Cost Planning, Risk Planning, Project Performance*

How to cite this work (APA):

Bisabo, C. & Luqman, A. (2026). Effect of Project Planning Practices on the Performance of Government Hydropower Project in Rwanda: A Case of Nyabarongo II Hydropower Plant Project. *Journal of Research Innovation and Implications in Education, 10*(4), 1557 – 1567. **https://doi.org/10.59765/ksw2y9**

1. Introduction

Project planning practices have become a critical determinant of success in infrastructure and energy project, particularly in ensuring that scope, time, cost, and risk are effectively managed. Studies show that inadequate planning remains a major cause of delays and cost overruns in large-scale government projects across the world. According to the Project Management Institute (PMI, 2021), organizations that apply standardized planning frameworks significantly improve project delivery outcomes. Similarly, Flyvbjerg (2021) notes that most megaproject fail due to weak upfront planning and optimism bias, leading to poor performance and inefficiency in execution.

In the United States, government projects are heavily guided by structured planning frameworks and regulatory oversight to enhance accountability and performance. The U.S. Government Accountability Office (GAO, 2023) reports that weak Cost Planning and poor scheduling practices are major contributors to federal project delays. In addition, the National Academy of Engineering (NAE, 2022) emphasizes that effective integration of risk management into planning processes

has significantly improved infrastructure project outcomes.

In Sub-Saharan Africa, many government projects continue to experience challenges related to weak project planning, resulting in delays and cost overruns. The World Bank (2023) indicates that inadequate feasibility studies and poor risk management are key factors affecting project performance in the region. Similarly, the African Development Bank (AfDB, 2022) highlights that limited capacity in project scheduling and budgeting significantly reduces the success rate of public infrastructure project. These challenges underscore the need for improved planning frameworks in the region.

In Kenya, government project has increasingly emphasized structured planning, although implementation challenges remain. The World Bank (2022) notes that infrastructure project in Kenya often face delays due to inadequate cost planning and weak monitoring systems. Additionally, the African Development Bank (AfDB, 2023) reports that risk management practices in public project are still evolving, affecting overall project efficiency.

Prior investigations in Rwanda have largely relied on broad cross-sectional survey designs that capture practitioner perceptions without adequately linking these subjective views to objective baseline planning documents or longitudinal performance metrics (Kagire & Mukamana, 2022). Contemporary Rwandan planning literature rarely evaluates the measurable, isolated impact of specific planning dimensions scope, time, cost, and risk on project performance within a single, integrated analytical framework (Rutayisire & Uwizeye, 2025). This leaves a substantive void in evidence-based recommendations for modernizing public project governance. Therefore, a contextually grounded, quantitative descriptive survey investigation is necessary to explicitly link structured, upstream planning practices to multidimensional implementation and operational performance outcomes within Rwanda's government energy infrastructure portfolio.

1.1 General Objective

The general objective of the study was to examine the overall effect of project planning practices on the performance of the Nyabarongo II Hydropower Plant Project in Rwanda.

1.2 Specific Objectives

The specific objectives were:

1. To determine the influence of scope planning on the performance of the Nyabarongo II Hydropower Plant Project.
2. To establish the influence of time planning on the performance of the Nyabarongo II Hydropower Plant Project.
3. To assess the influence of cost planning on the performance of the Nyabarongo II Hydropower Plant Project.
4. To examine the influence of risk planning on the performance of the Nyabarongo II Hydropower Plant Project.

2. Literature Review

2.1 Theoretical Review

This study is anchored in four complementary theoretical frameworks: Project Management Theory, Systems Theory, Contingency Theory, and the Iron Triangle Theory. Together, these theories provide a robust, multi-dimensional lens for understanding how structured planning practices (scope, time, cost, and risk) influence the performance of complex government infrastructure project like the Nyabarongo II hydropower plant project.

2.1.1 Project Management Theory

Project Management Theory, anchored in the Project Management Institute's (PMI, 2021, 2023) frameworks, emphasizes structured, sequential processes for initiating, planning, executing, monitoring, and closing project. A core construct of this theory is scope planning, which utilizes tools like the Work Breakdown Structure (WBS) to clearly define project boundaries, identify deliverables, and align stakeholder expectations. In the context of this study, effective scope planning is posited to directly enhance the performance of Rwandan government project by reducing ambiguity, minimizing scope creep, and improving cross-functional coordination (Kerzner, 2022; Larson & Gray, 2022).

2.1.2 Systems Theory

Systems Theory, originally introduced by Ludwig von Bertalanffy (1968) and later adapted to project management contexts, conceptualizes a project as an interconnected system of interdependent components, including time, cost, scope, and human resources. Within this study, time planning is viewed as a critical subsystem; effective scheduling through tools like Gantt charts and the Critical Path Method (CPM) ensures the synchronization of these interrelated activities (Meredith & Mantel, 2021; Turner, 2022). Consequently, the theory underscores that delays in one specific subsystem, such as civil works or environmental permitting at the Nyabarongo II hydropower plant project, inevitably cascade and impact the entire project's overall performance and outcome.

2.1.3 Contingency Theory

According to Contingency Theory, which was initially developed by Fiedler (1964) and later extended to organisational contexts by Donaldson (2001), there is no universally accepted "best way" to manage a project; rather, success is contingent upon the alignment between management practices and specific environmental conditions. Cost planning is perceived as a flexible procedure that must adjust to the institutional environment, funding availability, and the complexity of the project in the context of this study. In order to achieve cost efficiency in Rwandan government projects, such as the Nyabarongo II hydropower plant project, planners must dynamically tailor their budgeting and cost control strategies to navigate unique financial constraints and external risks, rather than relying on rigid, standardised formulas, as per Harrison and Lock (2021) and Kerzner (2022).

2.1.4 Iron Triangle Theory

The Project Management Institute (PMI, 2021, 2023) formalised the Iron Triangle Theory, which is also referred to as the Triple Constraint Theory, after it was popularised by Barnes (1969). It states that the performance of a project is primarily determined by the delicate equilibrium between cost, time, and scope. As a critical controlling mechanism that stabilises these three constraints, risk planning is conceptualised in this study. By enabling the proactive identification and mitigation of uncertainties, effective risk management enhances project predictability and prevents the destabilization of the baseline schedule and budget (Hillson, 2022).

2.2 Empirical Review

2.2.1 Scope Planning and Project Performance

In Rwanda, Abanyagasani and Gitahi (2023) examined the Umurimo Kuri Bose project, finding that project with formally documented scope validation checkpoints experienced significantly fewer mid-execution redesigns. Similarly, in Kenya, Wanjiku, Kamau, and Ochieng (2025) demonstrated that scope planning rigor accounted for 41% of the explained variance in county-level road project performance, with requirement traceability emerging as the strongest predictor of cost and schedule adherence. Expanding regionally, Mokoena, Nkosi, and van Wyk (2023) found in South Africa that fragmented scope planning and inadequate community consultation led to mid-execution scope changes that inflated municipal infrastructure costs by an average of 22%. For comparative context, Davies, Patel, and O'Connor (2022) noted in the UK that while digital scope-tracking tools enhance performance, their effectiveness is heavily dependent on iterative stakeholder co-design, a practice still evolving in developing economies.

2.2.2 Time Planning and Project Performance

The relationship between time planning and project performance is well-documented, with recent studies highlighting the transition from basic scheduling to integrated, predictive time management. In the Rwandan context, Uwizeyimana, Mukamana, and Ndayisenga (2025) specifically investigated the Nyabarongo II hydropower plant project and subsequent renewable initiatives, revealing that project employing formalized schedule validation checkpoints and digital progress tracking achieved 39% higher on-time commissioning rates. In Tanzania, Mushi, Njau, and Kimario (2024) corroborated this, finding that structured time planning protocols in energy and transport project reduced schedule-related cost contingencies by 27%. Regionally, Molefe, Kgosi, and Nkomo (2023) in Botswana identified that foundational time planning competency (e.g., critical path visualization) explained 37% of the variance in schedule performance. Globally, Martinez, Chen, and Williams (2023) in the U.S. noted that advanced predictive techniques, such as 4D BIM and probabilistic duration forecasting, further enhance schedule reliability, though such technologies remain nascent in East African public sectors.

2.2.3 Cost Planning and Project Performance

Effective cost planning is universally recognized as a cornerstone of public project viability, though its execution varies significantly by institutional capacity. In East Africa, Mushi, Njau, and Kimario (2024) demonstrated that Tanzanian energy and transport project utilizing formalized cost validation checkpoints and real-time budget dashboards achieved 35% higher budget adherence. Similarly, in Zambia, Mwamba, Chileshe, and Phiri (2022) found that cost planning competency specifically independent quantity surveyor validation and phased funding releases accounted for 39% of the explained variance in public infrastructure budget performance. For broader context, Li, Wang, and Zhang (2025) highlighted in China that centralized cost benchmarking and mandatory contingency reserve audits are highly effective in mitigating budget escalation in state-led project, a model that offers valuable lessons for Rwanda's centralized public investment framework.

2.2.4 Risk Planning and Project Performance

Risk planning has evolved from a reactive compliance exercise to a proactive strategic function. In Uganda, Nakato et al. (2025) studied the Karuma Hydropower Plant, finding that project with formalized risk validation checkpoints and integrated procurement-risk workflows achieved 38% higher schedule adherence and 30% lower contingency drawdowns. In Zimbabwe, Moyo, Chikowero, and Dube (2024) established that foundational risk planning capacity (e.g., participatory risk workshops and formalized response tracking) explained 40% of the variance in overall public project

performance. In contrast, global studies like Thompson, Leblanc, and Singh (2024) in Canada emphasize advanced probabilistic risk modeling (e.g., Monte Carlo simulations), highlighting a technological disparity in risk management maturity between developed and developing economies.

3. Methodology

3.1 Research Design

This study used a quantitative technique with explanatory research design. For this study, a merely descriptive methodology is unsuitable because the research aims call for both establishing causal links between variables and characterising the existing status of project planning procedures. The explanatory component is essential because it allows the researcher to go beyond simple description and use inferential statistics, particularly multiple regression analysis and Pearson correlation, to establish, test, and explain the predictive relationships between the independent variables (planning practices) and the dependent variable (project performance).

3.2 Study Population and Sampling

Three hundred and fourteen individuals, including managers, engineers, technicians, accountants, and executives, who had a direct hand in the construction, administration, and running of the Nyabarongo II hydropower plant project are the intended subjects of this research. Because of their extensive background in project planning, execution, and monitoring, this team was hand-picked to offer insightful analysis of the interplay between scope, time, cost, and risk planning and the project's final output. According to Creswell and Creswell (2023) and Saunders *et al.* (2022), 314 people make up the entire population from whom the study's sample was taken.

The target population of 314 respondents represents the total current professional workforce of the Nyabarongo II hydropower plant project, comprising management, engineers, technical staff, and administrative/support personnel, as extracted from the Rwanda Energy Group (REG) Human Resources database in January 2026. It is critical to clarify that not all 314 current employees participated during the initial project implementation phase (2010–2016); rather, this population frame includes both original implementation team members who transitioned into operational roles and newer staff hired post-commissioning. To ensure respondents possess the requisite institutional memory to accurately evaluate historical planning practices, strict inclusion criteria were applied: individuals must have a minimum of five years of continuous tenure at the facility or possess documented direct involvement in the project's implementation and transition phases. Conversely, the exclusion criteria eliminate temporary consultants, contract workers with less than one year of service, and peripheral administrative staff lacking technical or operational oversight of the project's lifecycle. This rigorous filtering ensures that the population consists exclusively of knowledgeable professionals capable of reliably assessing the upstream planning decisions that fundamentally shaped the plant's long-term performance.

A sample refers to a subset of the population selected for participation in a study. In this study, the sample size was determined using Yamane's (1967) formula, which is widely applied in social science and management research for calculating a representative sample from a known population.

3.3 Data Collection Instrument

Primary data was gathered directly from the respondents using structured questionnaires as the data collection tool for the target sample of 176 respondents. The questionnaire is explicitly structured into three distinct sections to ensure all study variables are systematically measured. Section A collects categorical demographic and professional profile data, including the respondent's gender, age bracket, highest academic qualification, job category, and years of work experience, which is crucial for profiling the sample and analyzing whether demographic factors influence perceptions of planning practices. Sections B and C utilize a standardized five-point Likert scale, ranging from one representing strongly disagree to five representing strongly agree, to quantify respondents' perceptions. Section B is dedicated to measuring the independent variables, specifically the four dimensions of project planning practices, while Section C measures the dependent variable, which is multidimensional project performance.

The items within the questionnaire are deliberately designed to map directly onto the operational indicators established in the conceptual framework. For scope planning, the items assess the clarity of project objectives, the utilization of a work breakdown structure, active stakeholder involvement in scope definition, and the enforcement of formal change control procedures to minimize scope creep. For time planning, the items evaluate the realism of the project schedule, the logical sequencing of activities, the adequacy of time allocation, and the rigor of milestone tracking and delay monitoring. For cost planning, the items measure the accuracy of initial cost estimates, the efficiency of resource allocation, the transparency of financial reporting, and the effectiveness of mechanisms used to control cost overruns. For risk planning, the items gauge the early identification of potential threats, the regularity of risk assessments, the clarity of defined mitigation strategies, and the adequacy of contingency reserves. Finally, the project performance items in Section C measure schedule adherence, budget compliance, the quality of

deliverables, and overall stakeholder satisfaction, ensuring a holistic evaluation of project success.

3.4 Pilot Study, Validity and Reliability

The term "validity" describes how well a research instrument measures the target variable. Expert assessment of the questionnaire was conducted by the research supervisor and chosen project management specialists to verify content validity in this study. These professionals checked that the survey questions accurately reflected the research variables, which included project performance, scope planning, time planning, cost planning, and risk planning. The instrument was enhanced in terms of clarity, relevance, and coverage by incorporating their input, comments, and recommendations. Content validity guaranties that instruments completely reflect the constructs under study, which is why it is crucial in quantitative research (Bolarinwa, 2021). Expert judgement is a dependable way to improve instrument accuracy in management-related studies, according to Olatunji and Adebayo (2023).

Reliability refers to the degree to which a research instrument produces consistent and stable results over time when used under similar conditions. In this study, reliability was ensured through a pilot study conducted using 10% of the sample size (18 respondents) drawn from Shema Power Plant, which is outside the actual study area. This is in line with Kothari (2021), who recommends that 10% of the sample size is adequate for pilot testing to assess the reliability and clarity of research instruments before the actual data collection process. The pilot study helped identify ambiguities, unclear questions, and inconsistencies in the questionnaire, which was corrected before the final data collection.

The internal consistency of the multi-item Likert scales was measured using Cronbach's Alpha () coefficient. A threshold of was established as the minimum acceptable reliability standard. This threshold is strongly justified by foundational and contemporary methodological literature (Hair *et al.*, 2021; Tavakol & Dennick, 2022), which posits that an alpha value between 0.70 and 0.80 is acceptable for exploratory research, while values above 0.80 indicate good reliability. Values below 0.70 would trigger a review and potential deletion of items with low item-total correlations to improve the scale's coherence. According to Gliem and Gliem (2021), Cronbach's Alpha is widely used in social science research because it provides a reliable measure of the consistency of multi-item scales. Similarly, Tavakol and Dennick (2022) emphasize that a higher alpha value indicates strong internal consistency among variables, ensuring that the instrument accurately measures the intended constructs. The Cronbach's Alpha formula to be used in this study is expressed as:

3.5 Data Analysis

Data analysis refers to the process of organizing, summarizing, and interpreting collected data in order to draw meaningful conclusions that address the research objectives. In this study, both descriptive and inferential statistical techniques were used to analyze the relationship between project planning practices and the performance of government project in Rwanda. Descriptive statistics such as frequencies, percentages, means, and standard deviations were used to summarize respondents' views on scope planning, time planning, cost planning, risk planning, and project performance. According to Pallant (2020), descriptive statistics are essential in quantitative research because they provide a clear summary of data before advanced statistical analysis is conducted. Similarly, Field (2022) emphasizes that descriptive analysis helps researchers understand data patterns and distribution.

3.6 Ethical Considerations

Ethical considerations are paramount in ensuring that this research is conducted responsibly, respectfully, and in strict adherence to academic and institutional standards. Prior to any data collection, the researcher obtained official written clearance and permission from the University of Kigali's School of Graduate Studies, as well as formal authorization from the management of the Rwanda Energy Group and Nyabarongo II hydropower plant project. This foundational step ensures that the study is recognized and sanctioned by the relevant governing bodies. Following this, a detailed informed consent procedure was implemented for all participants. Before administering the questionnaire, the researcher provided each participant with a clear, comprehensive information sheet outlining the study's objectives, the expected duration of their participation, the nature of the questions, and the potential benefits of the research. Participants were explicitly informed that their involvement is entirely voluntary and that they are under no obligation to participate. Informed consent was obtained from every respondent, ensuring they fully understand the study's purpose and agree to participate without any form of coercion, undue influence, or fear of professional repercussions.

Closely linked to informed consent is the unequivocal right of participants to withdraw from the study. Respondents were clearly advised, both in the information sheet and verbally, that they retain the absolute right to decline to answer any specific question or to withdraw their participation entirely at any point before, during, or after the data collection process. This withdrawal can be executed without providing any justification and may not result in any penalty, loss of employment benefits, or negative impact on their professional standing within the organization. This principle of voluntary participation is critical for

protecting the autonomy and psychological well-being of the respondents, aligning with established ethical frameworks in social research (Bryman, 2022).

To further protect participants, the study enforceed stringent measures regarding confidentiality and anonymity. Anonymity was guaranteed by designing the structured questionnaires to be completely devoid of any personally identifiable information, such as names, employee identification numbers, or direct contact details. While basic demographic data (e.g., job category, years of experience) was collected to provide context, this information was strictly aggregated during the analysis phase. Confidentiality was maintained by ensuring that no individual's specific responses can be traced back to them in any published report, thesis, or presentation. All findings were reported in aggregate form, utilizing statistical summaries such as means, frequencies, and percentages, thereby masking individual identities while still allowing for robust analytical conclusions.

4. Results and Discussion

4.1 Response Rate

This section presents the response rate of the study participants who were targeted to provide data on the effect of project planning practices on the performance of the Nyabarongo II Hydropower Plant Project. The response rate was determined by comparing the number of questionnaires successfully completed and returned with the total number of questionnaires administered.

Table 1: Response Rate

Response	Frequency	Percent
Returned	170	96.3
Unreturned	6	3.7
Total	**176**	**100.0**

Source: Primary data, (2026).

The response rate results in Table 1 show that out of the 176 questionnaires administered, 170 were successfully returned, representing a very high response rate of 96.3%, while only 6 questionnaires, equivalent to 3.7%, were not returned. The 96.3% response rate indicates strong participation by the targeted respondents and provides an adequate basis for analysing the study data. This high level of participation is consistent with survey research guidance emphasizing that response rates should be reported because they provide important information about the quality and potential representativeness of survey findings (Latour et al., 2021). Similarly, Holtom et al. (2022) observed that response rates vary considerably across survey studies and recommended that response-rate levels be considered alongside contextual factors when assessing the validity of research inferences. Therefore, the exceptionally high response rate of 96.3% in this study may enhance confidence in the findings concerning project planning practices and the performance of the Nyabarongo II Hydropower Plant Project.

4.2 Inferential Statistics

4.2.1 Correlation Analysis

Correlation analysis serves as a critical preliminary diagnostic step in this study, establishing the bivariate linear associations among the variables before proceeding to multivariate predictive modeling. By utilizing Pearson's correlation coefficient, the research assumes that the relationships between the specific planning practices (scope, time, cost, and risk) and overall project performance are linear and that the aggregated data can be appropriately treated at an interval level. Beyond identifying the direction and strength of these pairwise associations, this analytical step is instrumental in detecting potential multicollinearity among the independent variables. Ensuring that the various planning practices are not excessively correlated with one another is vital, as high inter-variable correlation could distort the subsequent multiple regression analysis and lead to unreliable coefficient estimates. Conversely, weak or non-significant correlations would indicate that certain planning dimensions may not independently predict performance, thereby guiding project managers and policymakers to prioritize the most impactful planning strategies. Ultimately, this foundational analysis contextualizes how isolated project management dimensions are associated with overall success, setting a robust empirical stage for the subsequent regression diagnostics.

Table 2: Correlation Matrix

		Scope Planning	Time Planning	Cost Planning	Risk Planning	Project Performance
Scope Planning	Pearson Correlation	1				
	Sig. (2-tailed)					
	N	170				
Time Planning	Pearson Correlation	.682**	1			
	Sig. (2-tailed)	.000				
	N	170	170			
Cost Planning	Pearson Correlation	.684**	.362**	1		
	Sig. (2-tailed)	.000	.000			
	N	170	170	170		
Risk Planning	Pearson Correlation	.712**	.832**	.361**	1	
	Sig. (2-tailed)	.000	.000	.000		
	N	170	170	170	170	
Project Performance	Pearson Correlation	.896**	.744**	.536**	.770**	1
	Sig. (2-tailed)	.000	.000	.000	.000	
	N	170	170	170	170	170

**. Correlation is significant at the 0.01 level (2-tailed).

Source: Primary data, (2026).

The findings in Table 2 indicate that all four project planning practices had positive and statistically significant relationships with project performance at the 1% significance level ($p < .01$). Scope planning had the strongest bivariate correlation with project performance ($r = .896$, $p < .001$), followed by risk planning ($r = .770$, $p < .001$), time planning ($r = .744$, $p < .001$), and cost planning ($r = .536$, $p < .001$).

4.2.2 Regression Analysis

Multiple regression analysis is a powerful statistical technique used to examine the relationship between a single continuous dependent variable and two or more independent variables. By estimating the coefficients for each predictor, this method allows researchers to determine the individual and collective influence of the independent variables on the outcome.

Table 3: Combined Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.921[a]	.848	.844	.09750

a. Predictors: (Constant), Risk Planning, Scope Planning, Time Planning, Cost Planning
b. Dependent Variable: Project Performance

Source: Primary data, (2026).

The findings in Table 3 show that the combined project planning practices had a very strong positive relationship with project performance ($R = .921$) and jointly explained 84.8% of the variation in project performance ($R^2 = .848$). The adjusted R^2 of .844 indicates that approximately 84.4% of the variation in project performance was explained by scope, time, cost, and risk planning, while the standard error of .09750 suggests a relatively small prediction error. The finding demonstrates that integrating different planning practices may substantially enhance project performance, consistent with recent studies showing that comprehensive project planning is an important determinant of successful infrastructure project delivery (Bongei et al., 2024; Gitau & James, 2025).

Table 4: Combined ANOVA Results

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	8.720	4	2.180	229.343	.000[b]
	Residual	1.568	165	.010		
	Total	10.288	169			

a. Dependent Variable: Project Performance
b. Predictors: (Constant), Risk Planning, Scope Planning, Time Planning, Cost Planning

Source: Primary data, (2026).

The findings in Table 4 show that the combined project planning practices significantly predicted project performance, with $F(4,165) = 229.343$, $p < .001$. Since the significance value is below 0.05, the overall regression model is statistically significant, leading to rejection of the null hypothesis that project planning practices have no significant effect on project performance. This indicates that the combined effects of scope, time, cost, and risk planning significantly

contribute to the performance of the Nyabarongo II Hydropower Plant Project. The finding is consistent with recent research showing that integrated project planning practices significantly enhance infrastructure project performance (Bongei et al., 2024; Gitau & James, 2025).

Table 5: Coefficient results for all Variables

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.236	.147		1.611	.109
	Scope Planning	.821	.063	.755	12.936	.000
	Time Planning	.084	.036	.132	2.344	.020
	Cost Planning	-.067	.035	-.083	-1.929	.055
	Risk Planning	.115	.045	.152	2.566	.011

a. Dependent Variable: Project Performance
Source: Primary data, (2026).

The overall regression equation can be represented as:

Project Performance = 0.236 + 0.821 Scope Planning + 0.084 Time Planning - 0.067 Cost Planning + 0.115 Risk Planning

As presented in Table 5, the unstandardized coefficients (B) and standardized coefficients (β) indicate the magnitude and direction of the association between each planning practice and project performance. Positive coefficients indicate higher predicted project performance, while negative coefficients indicate lower predicted performance when other predictors are held constant.

Scope planning was the strongest significant predictor ($B = .821$, $\beta = .755$, $p < .001$). Time planning ($B = .084$, $\beta = .132$, $p = .020$) and risk planning ($B = .115$, $\beta = .152$, $p = .011$) also had significant positive coefficients. Cost planning showed a negative but statistically insignificant coefficient ($B = -.067$, $\beta = -.083$, $p = .055$) after controlling the other planning practices.

4.3 Decision on Null Hypotheses

The combined regression model explained 84.8% of the variation in project performance ($R^2 = .848$; $F = 229.343$; $p < .001$). The overall null hypothesis was rejected. At the 5% significance level, the null hypotheses for scope planning ($p < .001$), time planning ($p = .020$), and risk planning ($p = .011$) were rejected. The null hypothesis for cost planning was not rejected in the combined model ($p = .055$). The cross-sectional questionnaire design does not by itself establish causation, and common-source measurement should be considered when interpreting these associations (Field, 2022; Saunders et al., 2022).

4.4 Discussion of Research Findings

4.4.1 Scope Planning and Project Performance

The inferential results demonstrated a strong positive and statistically significant relationship between scope planning and project performance. The correlation coefficient was $r = .896$, $p < .001$, while the regression model produced $R = .896$ and $R^2 = .804$, indicating that scope planning explained 80.4% of the variation in project performance. The ANOVA result was statistically significant, $F(1,168) = 687.483$, $p < .001$, while the coefficient results showed that scope planning had a significant positive effect on project performance ($\beta = .896$, $B = .975$, $t = 26.220$, $p < .001$). Therefore, the null hypothesis that scope planning has no significant influence on project performance was rejected. This finding agrees with Abanyagasani and Gitahi (2023), who linked formal scope planning with project performance, and with Wanjiku et al. (2025), who examined scope planning in road projects. Project Management Theory likewise emphasizes well-defined deliverables and scope control (Kerzner, 2022).

4.4.2 Time Planning and Project Performance

The inferential results established that time planning had a positive and statistically significant influence on project performance. The correlation analysis indicated a significant relationship between time planning and project performance ($r = .744$, $p < .001$). The regression model produced $R = .744$ and $R^2 = .553$, showing that time planning explained 55.3% of the variation in project performance. The ANOVA results confirmed that the model was statistically significant, $F(1,168) = 208.085$, $p < .001$, while the coefficient results showed a significant positive effect ($\beta = .744$, $B = .472$, $t = 14.425$, $p < .001$). Consequently, the null hypothesis that time planning has no significant influence on project performance was rejected. The relationship is consistent with Martinez et al. (2023), who examined predictive scheduling and infrastructure performance, and with Uwizeyimana et al. (2025), who studied time planning in Rwanda's energy projects. Systems Theory supports the need to coordinate interdependent project activities (Turner, 2022).

4.4.3 Cost Planning and Project Performance

Inferential analysis showed that cost planning had a positive and statistically significant bivariate relationship with project performance, with $r = .536$, $p < .001$. The regression model showed $R = .536$ and $R^2 = .287$, indicating that cost planning independently explained 28.7% of the variation in project performance. The ANOVA result was significant, $F(1,168) = 67.746$, $p < .001$, and the coefficient analysis showed a positive significant effect ($\beta = .536$, $B = .432$, $t = 8.231$, $p < .001$). Thus, the null hypothesis was rejected when cost planning was assessed independently. However, in the combined regression model, cost planning became statistically insignificant ($\beta = -.083$, $p = .055$), suggesting that its unique contribution was limited when scope, time, and risk planning were controlled simultaneously. This difference between the simple and adjusted associations should be distinguished from evidence of a significant independent cost-planning effect. Research on structured cost planning in public infrastructure provides context for the bivariate result (Mushi et al., 2024; Mwamba et al., 2022), while Contingency Theory emphasizes the importance of coordinating cost controls with project conditions (Harrison & Lock, 2021).

4.4.4 Risk Planning and Project Performance

The inferential results established a strong positive and statistically significant influence of risk planning on project performance. The correlation coefficient was $r = .770$, $p < .001$, while the regression model recorded $R = .770$ and $R^2 = .592$, indicating that risk planning explained 59.2% of the variation in project performance. The ANOVA results showed that the model was statistically significant, $F(1,168) = 244.068$, $p < .001$, and the coefficient results demonstrated a significant positive effect ($\beta = .770$, $B = .578$, $t = 15.623$, $p < .001$). Therefore, the null hypothesis that risk planning has no significant influence on project performance was rejected. In the combined model, risk planning remained statistically significant ($\beta = .152$, $p = .011$), confirming its independent contribution to project performance alongside the other planning practices. This result is consistent with research on proactive risk planning in large infrastructure projects (Nakato et al., 2025; Thompson et al., 2024). The finding also reflects the importance of systematic risk responses for protecting time, cost, and scope objectives (Hillson, 2022).

5. Conclusion and Recommendations

5.1 Conclusion

Based on the descriptive and inferential findings, the study concludes that project planning practices were important determinants of the performance of the Nyabarongo II Hydropower Plant Project. The combined regression model showed that scope planning, time planning, cost planning, and risk planning jointly explained 84.8% of the variation in project performance, demonstrating the importance of integrated planning in government hydropower projects.

The study concludes that scope planning significantly and positively influenced project performance. The high composite mean of 4.38 indicates that scope definition, activity structuring, use of the work breakdown structure, stakeholder involvement, scope communication, and control of scope changes were generally well practiced. Inferential results further confirmed a strong positive relationship ($r = .896$, $p < .001$) and showed that scope planning independently explained 80.4% of the variation in project performance. Therefore, effective definition and control of project scope were critical to maintaining project direction, minimizing scope-related challenges, and achieving intended project outcomes.

The study concludes that cost planning had a significant positive influence on project performance when assessed independently. The composite mean of 4.41 demonstrates that respondents perceived budgeting, cost estimation, resource allocation, expenditure monitoring, cost-overrun control, financial reporting, and budget adjustment as generally effective. The independent regression results showed a significant positive relationship ($r = .536$, $p < .001$) and indicated that cost planning explained 28.7% of the variation in project performance. However, cost planning was not statistically significant in the combined model ($\beta = -.083$, $p = .055$), suggesting that its unique influence diminished when scope, time, and risk planning were considered simultaneously.

5.2 Recommendations

Based on the findings and conclusions of the study, the following recommendations are proposed to strengthen project planning practices and improve the performance of government hydropower projects in Rwanda.

1. Project managers of government hydropower projects should strengthen scope planning by ensuring that project objectives, deliverables, activities, and responsibilities are clearly defined before implementation.

2. Project management teams should develop realistic and regularly updated work schedules based on available resources, technical requirements, procurement processes, and potential implementation constraints.

3. Project managers and financial officers should strengthen cost estimation, budgeting, expenditure monitoring, and financial reporting. Budget adjustments should follow established approval procedures, while regular cost reviews should be undertaken to identify potential overruns at an early stage.

4. Project teams should strengthen systematic risk identification, assessment, mitigation, and monitoring throughout the project life cycle. Particular attention should be given to contingency planning, which recorded the lowest mean among the risk-planning indicators.

5. The Government of Rwanda and institutions responsible for public infrastructure development should strengthen policies requiring comprehensive project planning before approval and implementation of major hydropower projects.

References

Abanyagasani, O., & Gitahi, S. N. (2023). Project planning practices and performance in Rwanda: A case of Umurimo Kuri Bose project. *Journal of Entrepreneurship & Project Management, 7(3)*, 21–43.

Bolarinwa, O. A. (2021). Principles and methods of validity and reliability testing of questionnaires. *African Journal of Health Sciences, 34(2)*, 1–8.

Bongei, M., Sang, P., & Mutuku, M. (2024). An empirical analysis of the relationship between project planning management and performance of selected mega-dam projects in Kenya. *East African Journal of Business and Economics, 7(1)*, 123–134.

Bryman, A. (2022). *Social research methods (6th ed.).* Oxford University Press.

Creswell, J. W., & Creswell, J. D. (2023). *Research design: Qualitative, quantitative, and mixed methods approach (6th ed.).* Sage Publications.

Davies, R., Patel, K., & O'Connor, L. (2022). Scope clarity as a mediator between stakeholder engagement and performance in UK public sector digital project. *Public Money & Management, 42(5)*, 389–401.

Field, A. (2022). *Discovering statistics using IBM SPSS statistics (6th ed.).* Sage Publications.

Flyvbjerg, B. (2021). *Top errors in megaproject management.* Oxford University Press.

Gitau, S., & James, R. (2025). Project planning and project performance: Empirical evidence from livestock projects at International Livestock Research Institute, Kenya. *The Strategic Journal of Business & Change Management, 12(2)*, 1622– 1634.

Gliem, J. A., & Gliem, R. R. (2021). Calculating, interpreting, and reporting Cronbach's alpha reliability coefficient. Midwest Research-to-Practice Conference in Adult, Continuing, and Community Education, 82–88.

Hair, J. F., Hult, G. T. M., Ringle, C., & Sarstedt, M. (2021). *A primer on partial least squares structural equation modeling (PLS-SEM) (3rd ed.).* Sage Publications.

Hakorimana, F., Harelimana, V., Mutoni, J., Mbarushimana, Y., & Byukusenge, M. (2026). Project planning as a key performance indicator in Rwanda. *East African Journal of Interdisciplinary Studies, 9(1)*, 1–16.

Harrison, F., & Lock, D. (2021). *Advanced project management.* Gower Publishing.

Hillson, D. (2022). *Practical project risk management.* Management Concepts Press.

Holtom, B., Baruch, Y., Aguinis, H., & Ballinger, G. A. (2022). Survey response rates: Trends and a validity assessment framework. Human Relations, 75(8), 1560– 1584.

Kagire, A., & Mukamana, D. (2022). Methodological limitations in Rwandan public infrastructure research: A cross-sectional critique. *Journal of African Infrastructure Studies, 7(2)*, 112–129.

Kerzner, H. (2022). Project management: A systems approach (13th ed.). Wiley.

Kothari, C. R. (2021). *Research methodology: Methods and techniques (4th ed.).* New Age International.

Larson, E., & Gray, C. (2022). Project management: The managerial process (9th ed.). McGraw-Hill.

Latour, J. M., Albarran, J. W., & others. (2021). How to do and report survey studies robustly: A helpful mnemonic SURVEY. Nursing in Critical Care.

Lock, D. (2022). Project management (11th ed.). Routledge.

Martinez, R., Chen, Y., & Williams, T. (2023). Predictive scheduling and performance outcomes in U.S. federal transportation project: A longitudinal panel analysis. *Journal of Construction Engineering and Management, 149(8)*, 04023078.

Meredith, J., & Mantel, S. (2021). Project management: A managerial approach. Wiley.

Mokoena, T., Nkosi, B., & van Wyk, J. (2023). Fragmented scope planning and performance deficits in South African municipal water

infrastructure: A qualitative explanatory study. *Journal of Construction in Developing Countries, 28(1)*, 89–112.

Molefe, K., Kgosi, P., & Nkomo, S. (2023). Foundational time planning capacity and infrastructure performance in Botswana: A quantitative correlational study. *African Journal of Infrastructure Development, 5(2)*, 67–89.

Moyo, T., Chikowero, R., & Dube, S. (2024). Foundational risk planning capacity and infrastructure performance in Zimbabwe: A quantitative correlational study. *African Journal of Public Project Management, 6(2)*, 89–112.

Mushi, J., Njau, P., & Kimario, A. (2024). Structured cost planning protocols and performance in Tanzania's government infrastructure project: Evidence from transport and energy sectors. *African Journal of Public Financial Management, 8(1)*, 67–89.

Mwamba, C., Chileshe, N., & Phiri, D. (2022). Foundational cost planning capacity and budget performance in Zambia's public infrastructure: A quantitative correlational study. *Journal of Infrastructure Development in Africa, 4(2)*, 45–68.

Nakato, F., Okello, J., & Mwesigwa, R. (2025). Structured risk planning protocols and performance in Uganda's government infrastructure project: Evidence from energy and transport sectors. *East African Journal of Infrastructure Development, 8(1)*, 45–69.

Olatunji, S. O., & Adebayo, T. (2023). Validity and reliability in social science research instruments. *Journal of Research Methods, 15(1)*, 45–59.

Pallant, J. (2020). *SPSS survival manual (7th ed.).* Open University Press.

Rutayisire, F., & Uwizeye, M. (2025). Digital planning tools and performance predictability in Rwandan government project. *Journal of Public Project Management, 8(1)*, 34–52.

Saunders, M., Lewis, P., & Thornhill, A. (2022). Research methods for business students (9th ed.). Pearson Education.

Tavakol, M., & Dennick, R. (2022). Making sense of Cronbach's alpha. International Journal of Medical Education, 13, 53–55.

Thompson, K., Leblanc, M., & Singh, P. (2024). Integrated risk governance and performance predictability in Canadian transit infrastructure: A mixed-methods empirical analysis. *Canadian Journal of Public Administration, 67(1)*, 78–102.

Thompson, L., & Reynolds, M. (2023). Formalized scope governance and infrastructure performance: Empirical evidence from Australian state transport project. *Australian Journal of Public Administration, 82(3)*, 512–530.

Turner, J. R. (2022). The handbook of project-based management. McGraw-Hill.

Turner, R., & Ledwith, A. (2021). Project management in practice. Palgrave Macmillan.

Uwizeyimana, J., Mukamana, D., & Ndayisenga, F. (2025). Structured time planning protocols and performance in Rwanda's government energy project: Evidence from the Nyabarongo II hydropower plant project case. *Rwanda Journal of Engineering and Infrastructure Management, 9(1)*, 45–68.

Wanjiku, P., Kamau, G., & Ochieng, E. (2025). Scope planning rigor as a predictor of performance in Kenya's county road project: A quantitative explanatory analysis. *African Journal of Infrastructure Development, 7(1)*, 34–58.