



Critical Success Factors and Road Infrastructure Project Performance in Rwanda: A Case Study of the Sonatube-Gahanga-Akagera Road

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Abstract: Road infrastructure projects are expected to meet schedule, cost, quality, and stakeholder requirements, yet their performance can vary across these dimensions. This study examined critical success factors and performance in the Sonatube-Gahanga-Akagera Road Project in Rwanda, while documenting implementation challenges as contextual evidence. A mixed-methods case study design was used. Questionnaire data were obtained from 50 purposively selected road-sector professionals, comprising 35 general respondents and 15 professionals directly involved in the project. Ten semi-structured interviews and a review of project records complemented the survey. Descriptive statistics summarized five-point Likert-scale responses, and Pearson correlations were examined exploratorily. Project-specific respondents rated financing ($M = 4.60$), planning ($M = 4.53$), and contractor competence and qualified personnel ($M = 4.47$ each) highly. The most salient project-specific challenges were land acquisition and compensation ($M = 4.33$), COVID-19 ($M = 4.20$), and design changes ($M = 3.93$); financial constraints ($M = 2.40$) and inflation ($M = 2.53$) were less prominent. Performance ratings were highest for achievement of objectives and budget performance ($M = 4.07$ each), followed by quality and stakeholder satisfaction ($M = 3.73$ each), while schedule performance was lowest ($M = 3.00$). Project records show that the original 24-month contract period extended to approximately 39 months and two weeks, although major works reached substantial completion. The available data did not show a statistically significant correlation between critical success factors and performance in either respondent group. The study recommends earlier right-of-way clearance, utility coordination, design readiness, and proactive schedule-risk management. The findings are case-specific and do not establish causality.

Keywords: Roads; Performance; Planning; Financing; Leadership; Rwanda; Supervision

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1. Introduction

Road infrastructure supports mobility, trade, access to services, and regional connectivity. Across Africa, investment in transport infrastructure remains important to economic transformation, although the value of these investments depends not only on construction but also on timely delivery, sound financial management, technical

quality, and stakeholder acceptance (African Development Bank, 2026; African Union Commission & Organisation for Economic Co-operation and Development, 2025). These performance dimensions are particularly relevant where road projects involve complex engineering works, multiple institutions, land acquisition, utility relocation, and public financing.

Project performance is commonly understood in terms of time, cost, and quality, but contemporary literature also emphasizes stakeholder satisfaction and the achievement of intended objectives (Shenhar et al., 2001). A project can deliver most of its planned physical output while still experiencing serious schedule delays. A balanced assessment therefore needs to examine several performance dimensions rather than classify a project as successful or unsuccessful on the basis of a single indicator.

The Sonatube-Gahanga-Akagera Road Project provides a relevant case for examining these issues in Rwanda. The approximately 13.8-km road upgrade was implemented for the Rwanda Transport Development Agency, with China Road and Bridge Corporation as the contractor and TECOS Ltd as the supervising consultant. The original contract amount was USD 53,954,298.50, excluding value-added tax, and the original implementation period was 24 months, from 19 March 2019 to 18 March 2021. Subsequent extensions moved the final completion date to 30 June 2022, giving an implementation period of approximately 39 months and two weeks. Project records describe the major works as substantially complete while also recording outstanding snags requiring correction (TECOS Ltd, n.d.).

Critical success factors (CSFs) are the managerial, technical, financial, and organizational conditions that professionals regard as especially important for successful project implementation. Prior studies identify planning, leadership, resource availability, contractor competence, stakeholder engagement, monitoring, and quality management as relevant factors in construction and road infrastructure projects (Borges et al., 2025; Ghanbari & Hasani, 2024; Pinto & Slevin, 1987). However, the importance of a factor in general is not the same as evidence that variation in that factor statistically explains performance in a particular project. This distinction is central to interpreting a small, single-case study.

The problem addressed in this study is the uneven performance of the Sonatube-Gahanga-Akagera Road Project across the assessed dimensions, especially the difference between the original schedule and the final completion date. Existing road-project studies have examined planning, stakeholder engagement, procurement, monitoring, and delay causes in different settings (Maendo et al., 2018; Mejía et al., 2020; Muzaale et al., 2025; Richu et al., 2025). Yet findings from other countries and project types do not automatically explain the experience of this specific Rwandan urban road project. Project-specific evidence combining professional perceptions, interviews, and project records is useful for identifying practical lessons while avoiding unsupported causal claims.

The study addressed three questions: (1) Which critical success factors were considered important by professionals

familiar with road infrastructure projects and the case-study project? (2) Which implementation challenges were reported, and how did the general sector perspective differ from direct project experience? (3) How was project performance assessed across time, cost, quality, stakeholder satisfaction, and achievement of objectives, and what exploratory associations were observed among the measured constructs? The article contributes a case-specific, mixed-methods account of these questions and identifies practical priorities for future road-project preparation and implementation.

2. Literature Review

2.1 Theoretical perspectives

Critical Success Factor Theory directs attention to the limited areas requiring adequate performance for an organization or project to achieve its objectives (Rockart, 1982). In project implementation, these areas can include planning, leadership, resource management, communication, technical competence, supervision, and quality control. Pinto and Slevin (1987) similarly emphasize that implementation success is shaped by a combination of project-related and organizational conditions rather than by one isolated practice. For road infrastructure, this perspective is relevant because construction involves interdependent technical activities, contractual responsibilities, public authorities, utility owners, financiers, and affected communities.

Project Performance Theory complements the CSF perspective by emphasizing how outcomes should be assessed. The traditional time-cost-quality model remains useful, but it may not capture whether the project met its objectives or addressed stakeholder expectations. Shenhar et al. (2001) describe project success as multidimensional, including immediate project efficiency, customer impact, organizational benefits, and longer-term value. In this study, performance was assessed through schedule, budget, quality, stakeholder satisfaction, and achievement of project objectives. Sustainability is important in road infrastructure literature, but it was not directly measured by the study questionnaire and is therefore not reported as an empirical outcome in this article.

2.2 Critical success factors in road infrastructure

Project planning establishes scope, sequencing, time targets, resource allocation, and risk responses. Resource management covers timely financing, qualified personnel, equipment, materials, and related inputs. Stakeholder engagement supports information exchange, coordination, and resolution of competing needs. Monitoring and evaluation provide information on progress and deviations,

while supervision and quality control help verify compliance with technical specifications. Leadership supports timely decisions and alignment among project participants, and contractor competence is important for mobilizing adequate staff, equipment, construction systems, and managerial capacity. These dimensions are related, but their operational significance differs from project to project. Empirical studies support the practical relevance of these areas. Maendo et al. (2018) examined monitoring and evaluation in road infrastructure projects in Kenya, while Murimi and Omwenga (2024) focused on project design and road construction performance. Ghanbari and Hasani (2024) examined success factors in road maintenance management in Iraq. Although the settings and methods differ, these studies reinforce the importance of planning, technical capacity, monitoring, and resource coordination. They also indicate why findings from a single indicator or a different country may not fully represent a specific Rwandan road project.

2.3 Implementation challenges and project performance

Road construction may encounter delayed land acquisition and compensation, utility conflicts, design changes, financial pressures, inflation, weather-related disruption, public-health events, and communication or coordination difficulties. These challenges may affect access to work fronts, construction sequencing, the movement of people and materials, or decisions requiring multiple institutions. Mejia et al. (2020) examined delay causes in road infrastructure projects in developing countries and highlighted the contextual nature of road-project delays. Muzaale et al. (2025) approached road infrastructure performance in Uganda through procurement, while Richu et al. (2025) examined stakeholder engagement and project performance in South Sudan. These studies indicate that implementation processes and institutional arrangements are important parts of the explanation, but they do not establish that the same factors affected every project in the same way.

The literature gap addressed here is therefore setting-specific and methodological. The reviewed work covers road projects in several countries and examines individual issues such as monitoring, design, stakeholder engagement, procurement, or delay causes. The present case study combines survey assessments from a wider professional group and project participants with interviews and project records. It also distinguishes between factors professionals consider important generally and challenges they say affected the Sonatube-Gahanga-Akagera Road Project. Because the design is observational and case-based, the study assesses perceptions and associations rather than making causal claims.

3. Methodology

3.1 Research design

A mixed-methods case study design was used to examine critical success factors, implementation challenges, and project performance in the Sonatube-Gahanga-Akagera Road Project. The case-study approach was appropriate because the study concerned one bound road infrastructure project and sought to interpret its implementation experience in context. Quantitative questionnaire results were combined with qualitative interview responses and documentary evidence. The study was descriptive and observational; it did not manipulate variables or establish experimental control.

3.2 Participants and sampling

Questionnaire participants were selected purposively because they had professional knowledge of road infrastructure planning, construction, supervision, or management. The sample comprised 50 respondents: 35 road-sector professionals who provided a broader sector perspective and 15 professionals directly involved in the case-study project from the client (RTDA), consultant (TECOS Ltd), and contractor (CRBC). All 50 questionnaires were returned, giving a 100% response rate. Ten semi-structured interviews were also conducted, including five participants with direct project experience and five wider road-sector professionals. The two questionnaire groups were analyzed separately because their instruments were related but not identical.

3.3 Data collection and analysis

The main data sources were structured questionnaires, semi-structured interviews, and project-document review. Questionnaire items used a five-point Likert scale. Eight CSF statements represented six conceptual indicators: project planning, resource management, stakeholder engagement, monitoring and evaluation, project leadership, and contractor competency. Five statements assessed project performance through schedule, budget, quality, stakeholder satisfaction, and achievement of project objectives. The questionnaires also asked about implementation challenges; the general and project-specific versions differed in some items. Interviews were used to obtain explanations of planning, resources, stakeholder coordination, technical management, implementation difficulties, and lessons learned. Records reviewed included the final project report, contract documents, progress reports, quality-control/testing records, payment information, technical reports, and available environmental and social monitoring records.

Quantitative data was coded and analyzed in SPSS. Frequencies and percentages summarized respondent characteristics, while means and standard deviations summarized Likert-scale assessments. Pearson product-moment correlations were used as exploratory measures of association among composite scores. Statistical significance was assessed at $\alpha = .05$. Open-ended questionnaire responses and interviews were coded thematically by identifying recurring ideas, grouping related codes, and comparing themes with the quantitative and documentary findings. The findings from the general respondents were used mainly as sectoral context; conclusions about the case-study project rely primarily on responses from project-specific participants and available project records.

3.4 Validity, reliability, and ethics

Instrument content was aligned with the study objectives, conceptual dimensions, and research questions. The interview guide and document-review checklist covered the same main topics while allowing more detailed explanations from interviewees. For the eight CSF items, Cronbach's alpha was .72 for the general group and .77 for the project-specific group, indicating reasonable internal consistency for those items sets in the available samples. The challenge items were heterogeneous and showed lower internal consistency ($\alpha = .57$ for the general group and .67 for the project-specific group). The five-item performance grouping had weak internal consistency in the general group ($\alpha = .47$) and a negative coefficient in the project-specific group ($\alpha = -.01$). Because the performance indicators measure distinct dimensions, they are interpreted individually rather than as a single reliable scale; correlations involving the composite scores are exploratory and must be interpreted cautiously. No separate pilot-study record was available, and no pilot results are claimed.

Participation was voluntary, respondents were informed of the academic purpose of the research, and responses were treated confidentially and reported in aggregate. Institutional permissions were obtained through the university research introduction process. Available site photographs and project records were used as contextual evidence; because a standardized observation duration and recording schedule were not documented, site observation

was not treated as a separately sampled quantitative or qualitative dataset in this article.

4. Results and Discussion

4.1 Respondent profile and evidence base

The 35 general road-sector respondents included professionals with substantial experience: 54.3% reported 11-15 years of experience and a further 20.0% reported more than 15 years. Among the 15 project-specific respondents, 46.7% reported more than 15 years of experience and 26.7% reported 11-15 years. The sample therefore provides informed professional perspectives, although it should not be viewed as a representative survey of all road-sector workers or project beneficiaries. The project-specific sample was balanced by organization, with five respondents each from RTDA, TECOS Ltd, and CRBC.4.2 Critical success factors

Table 1 presents the CSF item means for both respondent groups. The general respondents gave the highest ratings to project leadership ($M = 4.74$, $SD = 0.44$), project planning ($M = 4.69$, $SD = 0.47$), monitoring and evaluation, and supervision (both $M = 4.60$). Financing and qualified personnel each recorded $M = 4.54$. Among the project-specific respondents, adequate financing was rated highest ($M = 4.60$, $SD = 0.51$), followed by planning ($M = 4.53$, $SD = 0.52$), qualified personnel and contractor competence (both $M = 4.47$), and leadership and stakeholder communication (both $M = 4.40$). Monitoring/supervision and quality control each recorded means above 4.30. These responses indicate that professionals considered planning, adequate resources, technical capacity, leadership, communication, monitoring, and quality management important to project implementation. The broad pattern is consistent with the CSF perspective and with studies highlighting technical capacity, monitoring, design, and stakeholder engagement in road-project delivery (Ghanbari & Hasani, 2024; Maendo et al., 2018; Murimi & Omwenga, 2024; Pinto & Slevin, 1987). However, high ratings indicate perceived importance; they do not by themselves establish that each factor caused a particular performance outcome. The eight questionnaire items also represent six dimensions unevenly, so the results are best interpreted as item-level assessments rather than as a separate multi-item validated scale for every dimension.

Table 1: Descriptive results for critical success factor items

Indicator / item	General M (SD)	Project-specific M (SD)
Project planning	4.69 (0.47)	4.53 (0.52)
Adequate project financing	4.54 (0.56)	4.60 (0.51)
Qualified and experienced personnel	4.54 (0.61)	4.47 (0.74)
Contractor competence	4.26 (0.70)	4.47 (0.52)
Stakeholder communication	4.26 (0.61)	4.40 (0.63)
Monitoring and evaluation / monitoring and supervision	4.60 (0.50)	4.33 (0.49)
Project leadership	4.74 (0.44)	4.40 (0.63)
Supervision / quality-control measures	4.60 (0.50)	4.33 (0.62)

Note. *M* = mean; *SD* = standard deviation. Item wording differed slightly between questionnaires, and results were analyzed separately by respondent group.

4.3 Implementation challenges reported by respondents

Table 2 summarizes selected challenge items. The general respondents perceived financial constraints (*M* = 4.57), land acquisition delays (*M* = 4.40), delayed compensation and poor stakeholder communication (both *M* = 4.37), and design changes (*M* = 4.20) as important sector-wide challenges. The project-specific respondents gave their highest challenge ratings to land acquisition/compensation (*M* = 4.33), COVID-19 disruption (*M* = 4.20), and design changes (*M* = 3.93). They gave lower ratings to financial constraints (*M* = 2.40) and inflation (*M* = 2.53).

The contrast between sector-wide perceptions and case-specific responses is important. Financial constraints and

inflation were identified as potential risks in the broader sector, but the project participants did not generally report them as major constraints on this project. Conversely, COVID-19 received a higher project-specific rating than the general sector rating. The interview themes provided context concerning access to the right of way, compensation, utility relocation, design adjustments, weather, and coordination among the client, consultant, contractor, utility agencies, and other parties. This pattern aligns with studies describing varied and context-dependent sources of delays in road infrastructure projects (Mejía et al., 2020; Muzaale et al., 2025; Richu et al., 2025). The results should not be interpreted as implying that every challenge listed by general respondents affected the case-study project to the same degree.

Table 2: Selected implementation challenges by respondent group

Challenge item	General M (SD)	Project-specific M (SD)
Land acquisition / compensation	4.40 (0.55) / 4.37 (0.65)	4.33 (1.05)
COVID-19 disruption	3.54 (0.78)	4.20 (0.94)
Design changes	4.20 (0.72)	3.93 (1.03)
Poor stakeholder communication	4.37 (0.49)	3.20 (1.01)
Stakeholder coordination	4.06 (0.77)	3.40 (1.06)
Utility relocation	4.06 (1.00)	3.00 (1.07)
Weather conditions	3.80 (0.83)	3.20 (1.21)
Financial constraints	4.57 (0.50)	2.40 (0.83)
Inflation	4.11 (0.83)	2.53 (0.92)

Note. M = mean; SD = standard deviation. For general respondents, land-acquisition delay and delayed compensation are shown in that order. Items differed across questionnaires; values are descriptive, not tests of between-group differences.

4.4 Multidimensional project performance

Table 3 shows that schedule performance was the lowest rated of the five dimensions in both groups. General respondents rated completion within the planned schedule at $M = 2.83$ ($SD = 0.89$). Project-specific respondents rated schedule performance at $M = 3.00$ ($SD = 1.13$). In contrast,

the project-specific group rated budget performance and achievement of overall objectives at $M = 4.07$ each, and quality and stakeholder satisfaction at $M = 3.73$ each. The general-sector ratings were more moderate for budget performance ($M = 3.11$), quality ($M = 3.63$), satisfaction ($M = 3.63$), and achievement of objectives ($M = 3.83$).

Table 3: Project performance indicators by respondent group

Performance indicator	General M (SD)	Project-specific M (SD)
Completion within planned schedule	2.83 (0.89)	3.00 (1.13)
Completion within approved budget	3.11 (0.99)	4.07 (0.70)
Required quality standards	3.63 (0.73)	3.73 (0.46)
Stakeholder satisfaction	3.63 (0.55)	3.73 (0.46)
Achievement of overall objectives	3.83 (0.66)	4.07 (0.26)

Note. M = mean; SD = standard deviation. Higher means indicate more positive assessments. The two respondent groups were analyzed separately

Documentary evidence supports the conclusion that performance was uneven across dimensions. The original execution period was 24 months, commencing on 19 March 2019 and originally scheduled for completion on 18 March 2021. Extensions moved the recorded final completion date to 30 June 2022, producing a total implementation period of approximately 39 months and two weeks (TECOS Ltd, n.d.). This confirms substantial schedule slippage relative to the original contract. Project records also show an original contract amount of USD 53,954,298.50 excluding VAT and a measured work value of USD 53,954,265.54, approximately 99.99994% of the original contract amount (TECOS Ltd, n.d.). That comparison describes the measured contract works; it does not establish that the project incurred no additional economic costs from extensions, compensation, financing, or other consequences.

The relatively positive ratings of cost, quality, stakeholder satisfaction, and objective achievement should also be interpreted carefully. The project records report substantial completion of the major works, but some snags remained for correction before closure. Moreover, respondents were road-sector professionals and project participants, not a

representative sample of all affected households, road users, or beneficiaries. The most defensible conclusion is therefore that the project achieved substantial physical and functional delivery while suffering from significant schedule underperformance. This supports the multidimensional view of project success described by Shenhar et al. (2001) and Borges et al. (2025).

4.5 Exploratory relationships among the study constructs

Pearson correlation results are summarized in Table 4. For the general respondents, critical success factors had a very weak positive association with project performance ($r = .118$, $p = .501$), while implementation challenges had a weak positive association with performance ($r = .304$, $p = .075$). The association between critical success factors and challenges was moderate and statistically significant ($r = .453$, $p = .006$). For project-specific respondents, critical success factors had a very weak positive association with performance ($r = .085$, $p = .765$), challenges had a weak positive association with performance ($r = .288$, $p = .297$), and critical success factors and challenges had a moderate positive association ($r = .474$, $p = .074$).

Table 4: Pearson correlations among study constructs

Respondent group	Relationship	r	p
General (n = 35)	Critical success factors-performance	.118	.501
General (n = 35)	Challenges-performance	.304	.075
General (n = 35)	Critical success factors-challenges	.453	.006*
Project-specific (n = 15)	Critical success factors-performance	.085	.765
Project-specific (n = 15)	Challenges-performance	.288	.297
Project-specific (n = 15)	Critical success factors-challenges	.474	.074

*Note. r = Pearson correlation coefficient. *p < .05. The project-specific sample was small; the correlations are exploratory and do not establish causation.*

Neither the CSF-performance nor the challenge-performance association was statistically significant at the 5% level in either respondent group. The significant association between CSFs and challenges in the general group should not be interpreted as evidence that success factors cause challenges; it indicates that the two composite scores co-varied within that broader sample. The positive signs of the challenge-performance correlations should likewise not be interpreted as showing that challenges improve performance. Measurement heterogeneity, differences in the respondent groups, and the small project-specific sample limit substantive conclusions. The results support a cautious interpretation of professional perceptions rather than a causal model.

5. Conclusions and Recommendations

5.1 Conclusions

Research question 1-critical success factors. Respondents considered project planning, financing, qualified personnel, contractor competence, leadership, stakeholder communication, monitoring, supervision, and quality control important to road-project implementation. In the case-study group, financing received the highest mean rating, followed by planning and technical competence. These factors are best interpreted as perceived enabling conditions; the descriptive results do not establish that each independently determined project performance.

Research question 2-implementation challenges. Land acquisition and compensation, COVID-19, and design changes were the most prominent issues reported by professionals directly involved in the case. Financial constraints and inflation were recognized as broader sector risks but received lower ratings as challenges affecting this project. This distinction demonstrates the importance of grounding conclusions in case-specific evidence rather than transferring general sector perceptions directly to an individual project.

Research question 3-performance and relationships. Project performance was multidimensional. Project-specific respondents assessed budget performance, quality, stakeholder satisfaction, and achievement of objectives more positively than schedule performance. Project documentation confirms that the original 24-month contract period extended to approximately 39 months and two weeks. The project achieved substantial physical completion, but schedule performance was a clear weakness. Exploratory correlations did not show statistically significant associations between CSFs or challenges and performance. The case study therefore provides practical insights, not evidence of causal effects or results that can be generalized statistically to all road projects in Rwanda.

5.2 Recommendations

From the findings of this study, the following recommendations are identified:

1. Implementing agencies should substantially complete right-of-way acquisition, valuation, compensation, and grievance resolution before handing over affected work fronts.
2. Where full clearance cannot be completed at once, work should be sequenced around sections that are ready for construction.
3. Utility mapping and relocation should be integrated into detailed design, procurement planning, and the baseline schedule, with responsibilities and deadlines agreed among the client, utility owners, consultant, and contractor.
4. Clients and consultants should strengthen design readiness through coordinated technical investigations, utility verification, constructability reviews, and multidisciplinary design checks before tendering. Project teams should adopt an actively maintained schedule-risk register covering land clearance, utility

relocation, design approvals, weather-sensitive activities, traffic/access restrictions, and external disruptions. Emerging risks should trigger corrective actions and escalation through regular progress meetings.

5. Monitoring should combine schedule, budget, quality, safety, environmental/social obligations, and unresolved stakeholder issues in a single periodic review. Project teams should record lessons learned at completion and carry them into future project preparation. These recommendations focus on issues supported by the case evidence and do not imply that inadequate financing was a major constraint on the Sonatube-Gahanga-Akagera Road Project.

5.3. Limitations and Implications for Further Research

The study was limited to one road project and a purposive sample of 50 questionnaire respondents, including only 15 project-specific professionals. The groups received related but non-identical questionnaires, so their descriptive scores should not be treated as a randomized between-group comparison. The project-specific correlations had limited statistical power and are exploratory. No separate pilot-study record was available; future studies should pretest questionnaires, report instrument modifications, and validate multi-item scales before full administration. The performance dimensions are substantively distinct, so future research should assess them separately or use a measurement model justified by a larger sample. Comparative studies across multiple Rwandan road projects, longitudinal work covering planning through defects-liability, and studies incorporating road users and affected communities would help establish broader patterns beyond professional perceptions.

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