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EFFECT OF TRIPLE CONSTRAINTS ON IMPLEMENTATION OF ROAD CONSTRUCTION PROJECTS IN KIGALI RWANDA. CASE STUDY OF KIGALI INFRASTRUCTURE PROJECT

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ABSTRACT

This study determined the effect of the Triple Constraints—time, scope, and cost—on the implementation of road construction projects in Kigali, Rwanda. The specific objectives include examining the impact of time constraints, establishing the influence of scope constraints, and analyzing the effects of cost constraints on these projects. A descriptive survey research design was utilized, allowing for the exploration of the relationships between these constraints and project implementation. The target population comprises 334 individuals representing diverse stakeholders involved in Kigali's infrastructure projects. A sample size of 183 was determined using Yamane's formula, employing stratified random sampling techniques to ensure representation across different categories. Data collection incorporated both primary and secondary sources; primary data was gathered through questionnaires, while secondary data included published literature from books and journals relevant to the study's focus. A pilot study involving 19 employees from Horizon Construction Company, representing 10% of the sample size, was conducted to validate the research instruments. Expert opinions were sought to establish the validity of the survey tools, and Cronbach's alpha coefficient was calculated to assess internal consistency. Data analysis was performed using SPSS version 25, applying both descriptive and inferential statistical methods. Descriptive statistics summarized the data using percentages, frequencies, and counts, while inferential statistics, including multiple regression analysis, was employed to explore relationships and predictions among the variables. Qualitative data was analyzed using thematic analysis, with findings presented in a narrative format supplemented by direct quotations. This comprehensive approach aims to provide insights into the implications of Triple Constraints on the successful implementation of road construction projects in Kigali. The results indicate that the constant term is 0.045, suggesting a baseline level of project implementation when all predictors are zero, but this is not statistically significant ($t = 0.316$, $p = 0.752$). Among the independent variables, time constraints ($B = 0.217$, $t = 3.806$, $p < 0.001$) demonstrate a positive and statistically significant effect, indicating that as time constraints increase, the implementation of road projects also improves. Scope constraints show the most substantial positive influence ($B = 0.575$, $t = 8.918$, $p < 0.001$), suggesting that a well-defined scope significantly enhances project implementation effectiveness. Lastly, cost constraints ($B = 0.197$, $t = 3.284$, $p = 0.001$) also have a

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positive impact, though less pronounced than scope constraints. The standardized coefficients (Beta) reveal that scope constraints have the strongest effect (β = 0.514), followed by time constraints (β = 0.242) and cost constraints (β = 0.222), indicating the relative importance of these constraints in the implementation of road construction projects. In conclusion, the findings highlight the significant role of scope, time, and cost constraints in the successful implementation of road construction projects, with scope constraints emerging as the most critical factor. It is recommended that project managers prioritize clear project scopes and allocate adequate time resources to mitigate delays and enhance overall project effectiveness. For future studies, it would be beneficial to explore additional factors influencing project implementation, such as stakeholder engagement and technological advancements, as well as conducting longitudinal research to assess the long-term impacts of these constraints over time.

Keywords: Triple Constraints, Road Construction Projects, Project Implementation, Kigali Infrastructure Project.

BACKGROUND OF THE STUDY

Road construction projects are essential for supporting global economic development and enabling transportation infrastructure (Li, Huang & Yuan, 2019). However, a number of obstacles that might have a substantial impact on the projects' results frequently make it difficult for them to be implemented successfully. Studies reveal that insufficient financial support may jeopardize the resilience and longevity of transportation infrastructure, resulting in elevated maintenance expenses and shortened lifespan (Alhassan, Cioffi-Revilla, & Crooks, 2019). Budgetary restrictions can also limit the scope of projects, making it more difficult to include crucial safety features and infrastructure upgrades (Van der Zwaan & Fehr, 2020). Due to time constraints, contractors could have to expedite the building process, which raises the possibility of mistakes, mishaps, and labor exhaustion (Goh & Lim, 2019). In addition to financial fines and disruptions to transportation networks, project completion delays can have negative economic effects (Kadu & Bhandari, 2019).

Road construction projects in the United States represent vital infrastructural endeavors essential for economic growth and societal development. However, the successful implementation of these projects is often challenged by various constraints, ranging from budget limitations to regulatory requirements. According to a study by Liu and He (2019) cost constraints frequently hinder road construction projects, impacting the quality and durability of infrastructure. Similarly, time constraints have been identified as a significant challenge, leading to rushed construction processes and compromised safety standards (Acharya *et al.,* 2020). Additionally, fluctuations in commodity prices and supply chain disruptions exacerbate resource constraints, posing significant challenges to project management (Wu *et al.,* 2021).

With rapid urbanization and increasing transportation demands, the efficient implementation of these projects is crucial for enhancing connectivity, facilitating trade, and promoting regional development (Hu & Lo, 2020). However, the successful execution of road construction projects in China is often hindered by various constraints that pose significant challenges to project managers and stakeholders. These constraints encompass a range of factors, including budget limitations, time pressures, resource scarcity, technical complexities, environmental regulations, and stakeholder interests (Wang *et al.,* 2019). Environmental constraints represent another critical aspect of road construction project, particularly in light of growing concerns about sustainability and climate change (Shen *et al.,* 2020). Compliance with environmental regulations and mitigation of adverse environmental impacts are essential for ensuring the long-term viability of infrastructure projects (Chen *et al.,* 2019). Failure to address environmental constraints adequately can lead to legal challenges, public opposition, and reputational damage to project stakeholders (Yang *et al.,* 2021).

The impact of triple constraints on road construction projects in Sub-Saharan Africa (SSA), is multifaceted. Budget constraints, exacerbated by limited public funding and inefficient resource allocation, often result in

substandard road quality and delayed project completion (Kiringai & Musembi, 2019). Moreover, time constraints associated with tight project schedules can lead to rushed construction practices, compromising safety standards and the long-term durability of roads (Gwilliam & Shalizi, 2019). Additionally, technical challenges such as poor soil conditions and inadequate infrastructure pose significant hurdles to successful project implementation (World Bank, 2020). Furthermore, the socio-political landscape of SSA introduces stakeholder constraints, including conflicting interests and bureaucratic hurdles, which further impede the progress of road construction projects (Kiringai & Musembi, 2019).

The complexity of road construction projects in South Africa is further compounded by resource scarcity and environmental considerations (Zietsman *et al.,* 2019). Scarce availability of skilled labor, construction equipment, and materials, as discussed by Moyo *et al.* (2020), can result in project delays, cost escalations, and substandard workmanship. Moreover, adherence to stringent environmental regulations, including those aimed at preserving biodiversity and minimizing ecological impacts, imposes additional challenges on project implementation (Adey *et al.,* 2019). As highlighted by Ntiamoah *et al.* (2019), failure to address these constraints effectively not only jeopardizes the sustainability of road infrastructure but also exacerbates environmental degradation and undermines public confidence in the governance of infrastructure development projects in South Africa.

Kenya's rapidly growing population and urbanization have resulted in increased demand for transportation infrastructure, placing pressure on the government to undertake road construction projects to improve connectivity and mobility (Adera *et al.,* 2019). However, the implementation of these projects is often hindered by various constraints, including limited funding, inadequate technical expertise, bureaucratic inefficiencies, and environmental concerns (Kariuki & Kiilu, 2020). Despite the government's efforts to invest in infrastructure development, including road construction, the sector faces numerous challenges ranging from budgetary constraints to technical and environmental limitations (Mutia, 2019).

In Rwanda, the government has embarked on an ambitious road infrastructure development agenda aimed at improving accessibility, promoting trade, and enhancing regional integration (World Bank, 2019). Despite the government's commitment to infrastructure development, road construction projects in Rwanda face numerous challenges, including budgetary constraints, limited resources, and technical complexities. The allocation of limited financial resources to infrastructure projects, amidst competing demands for social services and development priorities, poses a significant challenge (Republic of Rwanda, 2019). Furthermore, the rugged terrain and adverse weather conditions in certain regions of the country present technical challenges, requiring innovative engineering solutions and specialized construction techniques (World Bank, 2020).

Among these projects, the Kigali Infrastructure Project stands out as a significant initiative aimed at improving the road network within the capital city, Kigali. As emphasized by Uwimana and Nsengiyumva (2020), the Kigali Infrastrucutre Project is part of Rwanda's broader vision to modernize its infrastructure and promote sustainable urban development. According to Gasana *et al.* (2019), the implementation of road construction projects in Rwanda faces various constraints, including budget limitations, time pressures, and technical challenges.

The implementation of road construction projects in Kigali, Rwanda, faces significant challenges due to the constraints of cost, time, and scope, often referred to as the "triple constraints" (Ogunlana, 2018). These constraints frequently lead to project delays, cost overruns, and compromised quality, particularly in developing countries where resource allocation and management capacity are limited (World Bank, 2020). In the case of the Kigali Infrastructure Project (KIP), these issues have been particularly pronounced, impacting the timely and cost-efficient delivery of key infrastructure needed to support Kigali’s rapid urbanization (National Institute of Statistics of Rwanda, 2021). Understanding how these constraints affect project outcomes is essential for improving project management practices and ensuring that future infrastructure projects meet their objectives.

Statement of the Research Problem

Road construction projects play a crucial role in infrastructure development, facilitating economic growth, and enhancing transportation networks. However, the successful implementation of these projects is often hindered by various constraints, including time, budget, resource, regulatory, technical, geographic, and stakeholder constraints (Gasana *et al.,* 2019). These constraints pose significant challenges to project managers and stakeholders, leading to delays, cost overruns, quality compromises, and safety concerns.

One of the primary gaps in the existing literature is the limited understanding of how various project constraints interact and influence each other throughout the different stages of road construction projects in Rwanda. While studies such as those by Uwimana and Nsengiyumva (2020) have provided valuable insights into the challenges facing infrastructure development in Rwanda, there remains a need for a focused examination of the unique constraints specific to road construction projects and their implications for project outcomes. Tight schedules and limited timeframes often result in rushed planning and construction phases, increasing the likelihood of errors, rework, and delays (Adnan *et al.,* 2018; Li & Wu, 2021). This not only impacts the efficiency of project delivery but also raises safety risks for workers and users of the road infrastructure. Furthermore, time constraints may impede thorough environmental assessments and community consultations, leading to inadequate consideration of social and environmental impacts (Chen & Zhang, 2019).

Furthermore, there is a lack of empirical evidence regarding the effectiveness of current mitigation strategies employed to address these constraints, highlighting the need for a comprehensive assessment of their impact on project success. Limited funding and budgetary constraints often force project teams to make compromises in material quality, construction methods, and maintenance activities (Ahmed *et al.,* 2020; Gao & Li, 2019). This can result in the use of substandard materials, which may lead to premature deterioration of the road infrastructure and increased long-term maintenance costs (Wu *et al.,* 2019). Moreover, budget constraints may hinder investments in innovative technologies and sustainable practices, limiting the long-term resilience and effectiveness of road construction projects (Feng *et al.,* 2020). Despite the recognized importance of cost management in construction projects, there is a gap in research focusing on the specific implications of budget constraints on road infrastructure development.

Objectives of the Study

General and specific objectives of the study are provided in this section.

General Objective

The general objective of this study is to determine the effect of triple constraints on implementation of road construction projects in Kigali Rwanda.

Specific Objectives

- To examine the effect of time constraints on implementation of road construction projects in Kigali Rwanda.
- To establish the effect of scope constraints on implementation of road construction projects in Kigali Rwanda.
- To analyze the effect of cost constraints on implementation of road construction projects in Kigali Rwanda.

Conceptual Framework

A conceptual framework serves as the theoretical foundation guiding research endeavors, providing a structure for understanding and analyzing complex phenomena. According to Miles and Huberman (2019), a conceptual framework offers a systematic approach to organizing concepts, variables, and relationships, facilitating the formulation of hypotheses and research questions. The conceptual framework delineates the theoretical constructs underpinning the study, helping researchers interpret findings and draw meaningful

conclusions (Hancock & Algozzine, 2020). It provides a lens through which researchers can conceptualize, contextualize, and interpret empirical evidence, enhancing the rigor and validity of research outcomes (Creswell & Creswell, 2019). By integrating relevant theories, models, and empirical evidence, a conceptual framework contributes to the advancement of knowledge within a particular field of inquiry, guiding future research directions (Tuckman & Harper, 2022). The conceptual framework delineates the dependent and independent variables, as expounded upon in the literature study and further elucidated in Figure 1 elucidates the interconnection between the independent and dependent variables.

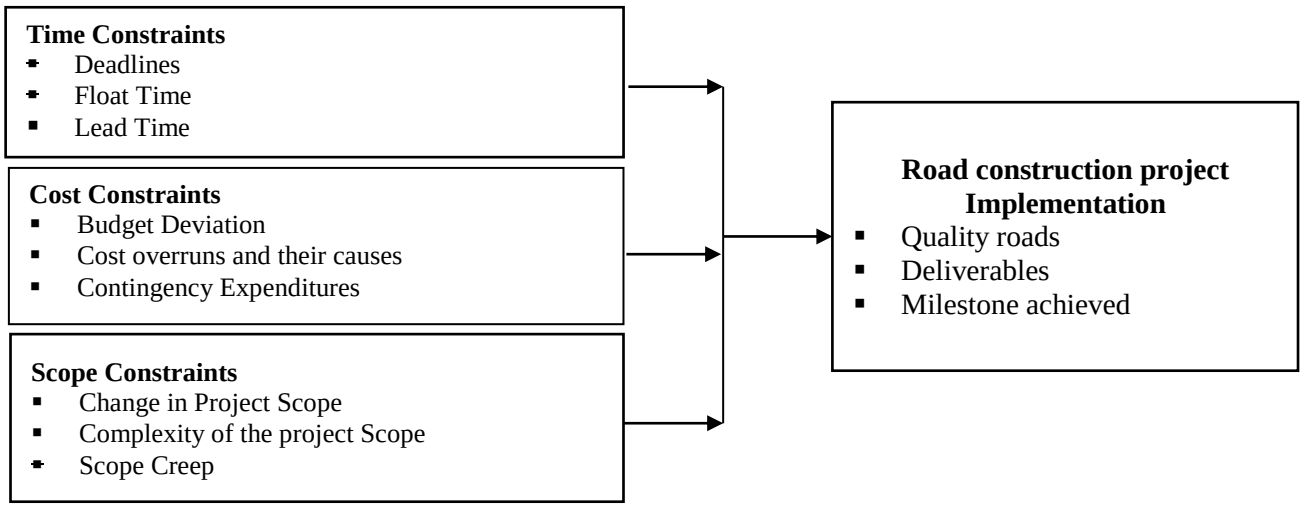

Figure 1: Conceptual Framework

Source: Researcher, 2024

The conceptual framework for this study is built upon three main pillars aimed at understanding the multifaceted impacts of project constraints on road construction projects in Rwanda. First, the investigation into the effect of time constraints on implementation, drawing from works such as Abdel-Razek *et al.* (2019) and Ogunlana *et al.* (2019), seeks to uncover how tight project schedules influence decision-making processes, resource allocation, and overall project quality. Second, the exploration of scope constraints' effects, as highlighted by studies like Chan and Kumaraswamy (2022) and Joshi and Dikshit (2023), delves into how limited project scope impacts material selection, construction techniques, and project outcomes. Lastly, the analysis of cost constraints' influence, informed by research from Laryea and Hughes (2019) and Ngowi *et al.* (2019), aims to elucidate the financial pressures on road construction projects, including budgetary limitations, resource availability, and cost management strategies.

Research Gaps

Despite the growing body of literature on road construction projects in Africa, several research gaps persist regarding scope constraints and their implications for project implementation. First, much of the existing research has primarily focused on cost and time constraints, often neglecting a comprehensive analysis of scope management practices (Ogwueleka, 2020; Olawale & Sun, 2018). Additionally, while several studies have acknowledged the challenges posed by scope changes, few have explored the underlying causes of these changes in-depth, particularly in the context of stakeholder interactions and regulatory influences (Kaboza *et al.,* 2021; Muwanga & Kiwanuka, 2022). Moreover, the literature often lacks longitudinal studies that examine how scope constraints evolve over time and their cumulative impact on project success (Akinola *et al.,* 2022; Diko *et al.,* 2019). Furthermore, research often overlooks the experiences of local contractors and project managers in adapting to scope changes, leading to a gap in understanding the practical implications of scope management in Uganda's unique socio-economic context (Muliira *et al.,* 2021; Ocan *et al.,* 2023).

Another significant gap is the limited exploration of innovative scope management strategies that can enhance project performance in the face of constraints. While some studies have suggested best practices, there is a need for empirical research that evaluates the effectiveness of specific strategies in the Ugandan context (Bashaasha *et al.,* 2020; Nandala *et al.,* 2021). Additionally, the impact of technology and digital tools on scope management in road construction projects remains under-researched, particularly how these tools can aid in managing scope creep and improving stakeholder communication (Gikunda *et al.,* 2021; Katende & Kyambadde, 2022). Furthermore, there is a lack of comparative studies that investigate scope management practices across different African countries, which could provide valuable insights into the factors influencing project outcomes (Omony *et al.,* 2022; Twaha *et al.,* 2021). Addressing these research gaps is essential for developing a more comprehensive understanding of scope constraints and their effects on road construction projects, ultimately leading to improved practices and policies in the sector.

METHODOLOGY

Research Design

The study adopted a descriptive survey design, which is particularly suited for capturing a comprehensive snapshot of the current state of scope constraints affecting the implementation of road construction projects in Kigali, Rwanda. This design enabled the collection of quantitative data through structured questionnaires distributed to a diverse group of stakeholders, including project managers, contractors, and government officials involved in road construction. By utilizing this approach, the study aims to identify and quantify the key scope constraints experienced in these projects and assess their impact on project outcomes. Additionally, descriptive survey design facilitates the gathering of qualitative insights through open-ended questions, allowing respondents to elaborate on their experiences and perceptions (Copper & Schindler, 2019). This combination of quantitative and qualitative data provided a holistic understanding of the challenges faced in scope management and support the formulation of recommendations to improve project implementation in the region.

Target population

The target population is events, or objects to which the outcomes of the study are intended at. It is the specific populace about which information is desired (Kothari & Gaurav, 2019). The target population included 334 respondents, including road designers, surveyors, site engineers, Quantity surveyors, Geotechnical engineers, Electrical engineers, Structural engineers, Material Engineers, Mechanical engineers, Project managers and Quality Control Engineers within Kigali infrastructure project (which aims to build 215 kms of asphalts roads) from NPD limited company.

Sample size and sampling procedure

In line with the definition provided by Mugenda and Mugenda (2019), sampling involves selecting a representative subset of a larger population to draw samples for research purposes. The choice of sample techniques, such stratified sampling or cluster sampling, depends on the study goals, population characteristics, and resource availability. Additionally, calculating the sample size needed balancing factors like statistical power, accuracy, and practicality while adhering to the study's limitations. The sample size was attained through the use following the formula used by Yamane’s formula as stipulated by Kothari (2019).

$$n = \frac{N}{1 + N\,(e)^2} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots Eqn\ 1$$

Where n = the sample size.

e = probability of error, i.e., the desired precision, 0.05 for 95% confidence.

When doing research, the choice between studying the whole population or opting for a representative subset (sample) is influenced by variables such as practicality, resources, and research goals. Researchers may easily collect data and ensure relevant and generalizable conclusions by choosing sampling. The research uses

Kothari's (2019) formula to determine the sample size, which is a well-accepted method for calculating the required sample size considering aspects like confidence level, margin of error, and demographic variability. This approach allows researchers to reconcile statistical rigor with practical data gathering limits, therefore improving the reliability and validity of study results.

$$n = \frac{N}{1 + N * e^2} = n = \frac{334}{1 + 334\ (0.05)^2} = 183$$

As a consequence of this, the sample size that was examined for the purpose of providing the main data that is necessary for this study is that of 183 staff members.

Table 1: Sampling Frame

Area of operation	**Population**	**Sample**
Road designers	35	19
Surveyors	30	16
Site engineer	40	22
Quantity surveyors	25	14
Geotechnical Engineers	20	11
Electrical Engineers	30	17
Structural Engineers	35	19
Materials Engineers	25	14
Mechanical Engineers	30	16
Project managers	30	16
Quality Control Engineers	34	19
Total	**334**	**183**

Source: Human Resource Department Kigali Infrastructure Project – (2024)

A stratified random sampling technique was employed to ensure representation across Road designers, Surveyors, site engineers, Quantity surveyors, Geotechnical engineers, Electrical engineers, Structural engineers, Material Engineers, Mechanical engineers, Project managers and Quality Control Engineers within Kigali infrastructure project from NPD limited company. This approach allows for the selection of participants based on key criteria such as their role in the project, level of involvement, and expertise. The sample size was determined using established statistical methods to ensure adequate power and generalizability of results (Creswell & Creswell, 2019). Additionally, purposive sampling may be utilized to include participants with diverse perspectives and experiences related to project implementation challenges in Rwanda's construction sector (Palinkas *et al.*, 2020). By employing a robust sampling strategy, this study aims to provide comprehensive insights into the factors influencing the successful execution of road construction projects in Kigali Rwanda, thus contributing to informed decision-making and improved project implementation.

Pilot Test

According to Creswell and Creswell (2019), a pilot test allows researchers to refine data collection instruments, identify potential logistical challenges, and assess the feasibility of the study design before full-scale implementation. The pilot test adopted for this study adhered to the recommended guideline proposed by Cooper and Schindler (2019), suggesting that 5% to 10% of the target sample size is sufficient for a pilot study. Given the anticipated sample size of 183 respondents for the main study, a pilot test involving–19 employees of HORIZON Construction Company was conducted, constituting 10% of the expected sample

size. By selecting a subset of participants from the target population, the pilot study aims to assess the feasibility and effectiveness of the research instruments, procedures, and data collection methods (Morgan, 2020). This smaller-scale trial enable the identification of potential issues or ambiguities in survey questions, data collection protocols, and sampling techniques, allowing for necessary refinements before the commencement of the main study. Furthermore, conducting the pilot test within the context of HORIZON Construction Company provided valuable insights into the applicability and relevance of the study's framework and objectives within the specific industry setting, thereby enhancing the validity and reliability of the research findings (Creswell & Creswell, 2019).

Validity of the instrument

Validity refers to the extent to which the instrument measures what it intends to measure (Trochim & Donnelly, 2019). In this study, the instrument used to assess project constraints must accurately capture the various dimensions of constraints such as time, cost, scope, quality, resources, and risks, as they pertain to construction projects in Rwanda. To ensure validity, the instrument should undergo rigorous validation procedures, including content validity, construct validity, and criterion validity (Trochim & Donnelly, 2019). Content validity ensures that the instrument adequately covers all relevant aspects of project constraints, while construct validity confirms that the instrument measures the intended constructs accurately. Criterion validity assesses the instrument's ability to predict or correlate with external criteria related to project performance or outcomes. By meticulously validating the instrument against these criteria, researchers enhanced the validity of their findings and contribute robust evidence to inform decision-making in construction project management.

Table 2: KMO and Bartlett's Test

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.858
Bartlett's Test of Sphericity	Approx. Chi-Square	838.418
	df	6
	Sig.	.000

Source: **Pilot data results**, (2024)

Table 2 presents the results of the Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy and Bartlett's Test of Sphericity, which are key indicators in assessing the suitability of data for factor analysis. The KMO value of 0.858 indicates that the sample size is adequate for conducting a factor analysis, as it surpasses the commonly accepted threshold of 0.6 (Kaiser, 2014). A high KMO value, close to 1, suggests that the correlations between variables are sufficiently compact, thus supporting the extraction of distinct and reliable factors (Tabachnick & Fidell, 2019). Bartlett's Test of Sphericity shows a significant Chi-Square value of 838.418 with a degree of freedom (df) of 6 and a significance (Sig.) value of .000, indicating that the correlations among the variables are significantly different from zero, further validating the appropriateness of factor analysis for this dataset. This test is crucial as it demonstrates that the variables are interrelated and not independent, making factor analysis a viable method for identifying patterns and dimensions within the data (Field, 2020).

Reliability of instrument

According to Sekaran and Bougie (2020), reliability refers to the extent to which a measurement instrument consistently yields the same results over multiple administrations under the same conditions. Therefore, the reliability of the instrument chosen for the study directly impacted the accuracy and trustworthiness of the findings. To establish instrument reliability, researchers may utilize techniques such as test-retest reliability, internal consistency measures of Cronbach's alpha was carried out. According to Nunnally and Bernstein (2019), a Cronbach's alpha value of 0.70 or higher indicates acceptable reliability, thus serving as a benchmark for evaluating the internal consistency of the instrument.

Table 3: Reliability Statistics

Variable	Alpha (α)	Comments
Time constraints	0.946	Reliable
Scope constraints	0.928	Reliable
Cost constraints	0.960	Reliable
Implementation of road construction projects	0.770	Reliable

Source: **Pilot Results**, (2024).

Table 3 presents the reliability statistics for the study's variables, evaluated using Cronbach's alpha (α), which assesses the internal consistency of the measurement scales. The results indicate that time constraints (α = 0.946), scope constraints (α = 0.928), and cost constraints (α = 0.960) all demonstrate high reliability, suggesting that the items within these constructs are consistently measuring the intended concepts. The implementation of road construction projects, with a reliability coefficient of α = 0.770, also shows acceptable reliability, albeit slightly lower than the other variables. These findings align with the established threshold for acceptable reliability, which is typically considered to be $\alpha \geq 0.70$, indicating that all variables in this study have sufficient reliability for further analysis (Tavakol & Dennick, 2011). This reliability assessment enhances the validity of the study's findings, providing confidence that the measurements used effectively capture the constructs of interest.

Data processing Analysis

Data analysis is a critical component of research that enables researchers to make sense of collected information and draw meaningful conclusions (Hair, *et al.,* 2019). In this study, data analysis primarily involved the utilization of statistical techniques, particularly for quantitative data. Software such as SPSS version 25 was employed to analyze quantitative data, allowing for the examination of relationships and patterns within the dataset. Descriptive statistics was utilized to summarize and present the data, providing insights into the characteristics of the variables under study. Additionally, inferential statistics such as regression analysis may be employed to assess the impact of various variables on the project constraints versus project implementation. Regression analysis enables the identification of significant predictors and the quantification of their effects on project implementation, thereby offering empirical insights into the factors influencing road construction projects in Rwanda.

Qualitative data, if collected, was subjected to thematic analysis, a process of identifying and examining recurring themes and patterns within the qualitative data (Braun & Clarke, 2020). Thematic analysis provides a systematic approach to analyzing qualitative data, allowing researchers to uncover insights, identify trends, and gain a deeper understanding of the underlying phenomena. By employing a mixed-method approach that combines quantitative analysis using statistical techniques and qualitative analysis through thematic analysis, this study aims to provide a comprehensive understanding of the factors affecting project implementation in the context of road construction projects in Rwanda.

In the regression analysis model employed in this study, Project Implementation (Y) is the dependent variable, while Time constraints (X_1), Cost constraints (X_2), and Scope constraints (X_3) serve as independent variables. The model is represented as $Y = \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \varepsilon$, where β_1, β_2, and β_3 are the coefficients for the respective independent variables. These coefficients indicate the magnitude and direction of the impact that time constraints, cost constraints, and scope constraints have on the Project Implementation. The error term (ε) represents the unexplained variability in the dependent variable that is not accounted for by the independent variables. By estimating the coefficients β1, β2, and β3, this regression model enables the investigation of how variations in time, cost, and scope constraints influence the overall implementation of construction projects in Rwanda, providing valuable insights for project management and decision-making processes.

RESULTS AND FINDINGS

Correlation Analysis

Correlation analysis is a statistical method used to measure the strength and direction of the relationship between two variables. This analysis provides insight into whether variables are positively, negatively, or not related at all. The correlation coefficient, often denoted as Pearson's r, ranges from -1 to +1, where values closer to +1 indicate a strong positive relationship, values closer to -1 indicate a strong negative relationship, and values near 0 suggest no linear relationship. Correlation analysis is commonly used in various fields, including economics, finance, and social sciences, to explore potential associations between variables and support decision-making processes. It is essential to note that correlation does not imply causation, meaning that even if two variables are correlated, one does not necessarily cause the other (Aguinis et al., 2021; Frost, 2023).

In the context of road construction projects, particularly within the Kigali Infrastructure Project, understanding the interplay between time constraints, scope constraints, and cost constraints is crucial for effective project management. Table 4 presents the correlation coefficients and the coefficient of determination for these variables in relation to the implementation of road construction projects.

Table 4: Correlation and the coefficient of determination

		Time constraints	Scope constraints	Cost constraints	Implementation of road construction projects
Time constraints	Pearson Correlation	1			
	Sig. (2-tailed)				
	N	170			
Scope constraints	Pearson Correlation	.838**	1		
	Sig. (2-tailed)	.000			
	N	170	170		
Cost constraints	Pearson Correlation	.885**	.859**	1	
	Sig. (2-tailed)	.000	.000		
	N	170	170	170	
Implementation of road construction projects	Pearson Correlation	.869**	.907**	.877**	1
	Sig. (2-tailed)	.000	.000	.000	
	N	170	170	170	170

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

Source: **Primary data, (2024).**

Table 4 presents the correlation matrix and coefficients of determination among key variables related to road construction project management: time constraints, scope constraints, cost constraints, and the overall implementation of road construction projects. The findings reveal a robust positive correlation between time constraints and scope constraints (Pearson correlation of 0.838, $p < 0.01$), indicating that as time constraints increase, so do issues related to scope management. This significant relationship suggests that projects with tight deadlines are more susceptible to scope changes, which aligns with existing literature that emphasizes the interconnectedness of time and scope in project management (Ika et al., 2022). Furthermore, a strong correlation exists between time constraints and cost constraints (0.885, $p < 0.01$), suggesting that increased pressure to meet deadlines often leads to budget overruns, supporting the notion that effective time management is critical in controlling costs in construction projects (Alzahrani & Emsley, 2020).

Additionally, the correlation of cost constraints with the implementation of road construction projects is also noteworthy, exhibiting a coefficient of 0.877 ($p < 0.01$). This high correlation indicates that effective management of cost constraints significantly impacts the successful implementation of road projects. The strongest correlation found in the table is between scope constraints and the implementation of road construction projects (0.907, $p < 0.01$), highlighting the vital role that well-defined project scopes play in successful project outcomes. These findings underscore the importance of addressing these constraints holistically to enhance project performance and sustainability in the construction sector. Overall, the results of this correlation analysis reinforce the need for integrated project management strategies that prioritize time, scope, and cost constraints to achieve successful project delivery (Wang *et al.,* 2023).

Multiple Regression Analysis

Table 5 illustrates the results of the multiple regression analysis conducted to evaluate the combined effects of time constraints, scope constraints, cost constraints, and stakeholder collaboration on the implementation of road construction projects. The model demonstrates a high correlation coefficient ($R = 0.933$), indicating a strong linear relationship between the independent variables and the dependent variable. The R-squared value of 0.871 signifies that approximately 87.1% of the variance in project implementation can be explained by the predictors, while the adjusted R-squared of 0.868 accounts for the number of predictors used, reflecting a good fit for the model. Additionally, the standard error of the estimate is 0.10879, suggesting that the average distance between the observed values and the predicted values of implementation is relatively small. These findings highlight the significance of managing multiple constraints and fostering collaboration among stakeholders to enhance project outcomes (Adnan et al., 2022).

Table 5: Combined Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.933[a]	.871	.868	.10879

a. Predictors: (Constant), Time constraints, Scope constraints, Cost constraints, Stakeholders collaboration

Source: **Primary data, (2024).**

Table 5 presents the results of the ANOVA analysis for the combined model, which assesses the impact of close collaboration, scope constraints, time constraints, and iterative methods on the implementation of road construction projects. The regression sum of squares is 13.225, indicating a substantial amount of variability explained by the model, while the residual sum of squares is 1.965, suggesting that only a small proportion of the total variability (15.190) remains unexplained. The F-statistic of 372.506 is significant at a p-value of .000, demonstrating that the predictors collectively have a statistically significant effect on the dependent variable. This strong F-value underscores the importance of incorporating collaborative approaches and managing constraints effectively to improve project implementation outcomes (Awan et al., 2021).

Table 6: Combined ANOVA Results

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	13.225	3	4.408	372.506	.000[b]
	Residual	1.965	166	.012		
	Total	15.190	169			

a. Dependent Variable: Implementation of road construction projects

b. Predictors: (Constant), Close collaboration, Scope constraints, Time constraints, Iterative methods

Source: **Primary data, (2024).**

Table 6 summarizes the coefficient results for all independent variables impacting the implementation of road construction projects. The model shows that the unstandardized coefficient for time constraints is 0.217 ($p < .001$), indicating a positive relationship with project implementation, meaning that as time constraints

increase, so does the effectiveness of project execution. Scope constraints have a significant unstandardized coefficient of 0.575 ($p < .001$), suggesting it has the strongest influence among the variables considered. Cost constraints also show a positive effect with an unstandardized coefficient of 0.197 ($p = .001$), confirming that effective management of financial resources is essential for successful project implementation. The overall significance of these coefficients highlights the necessity of addressing time, scope, and cost factors in road construction project management for improved outcomes (Rachmawati et al., 2022).

Table 7: Coefficient results for all Variables

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	.045	.143		.316	.752
	Time constraints	.217	.057	.242	3.806	.000
	Scope constraints	.575	.064	.514	8.918	.000
	Cost constraints	.197	.060	.222	3.284	.001

a. Dependent Variable: Implementation of road construction projects

Source: **Primary data, (2024).**

The beta coefficients of the study were illustrated in table 7. The values of the constant and coefficients enabled the generation of the multiple regression model as follows:

$$\mathbf{Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \varepsilon}$$

Implementation of road construction projects = 0.045 + 0.217 Time constraints + 0.575 Scope constraints + 0.197 Cost constraints

This equation illustrates the linear relationship between the dependent variable (implementation of road construction projects) and three independent variables: time constraints, scope constraints, and cost constraints. The constant term (0.045) indicates the baseline level of implementation when all independent variables are zero. The coefficients (0.217 for time constraints, 0.575 for scope constraints, and 0.197 for cost constraints) reflect the magnitude and direction of their impact on project implementation, with scope constraints having the most substantial effect, suggesting that effectively managing scope is critical for successful outcomes in road construction projects. The statistical significance of these coefficients confirms their relevance in project management literature (Zhang *et al.*, 2023).

CONCLUSIONS

The results indicate significant relationship between agile project management and performance of mining projects in Rwanda.

The conclusions of the study highlight that effective management of scope, time, and cost is crucial for the successful execution of infrastructure projects. Furthermore, the findings indicate that a balanced approach to these constraints can significantly enhance project outcomes, ensuring timely delivery while maintaining quality and staying within budget.

In conclusion, the findings highlight that time constraints significantly affect the implementation of road construction projects. The strong positive correlation and the substantial variance explained by time constraints underscore the necessity for effective time management strategies in project planning and execution. To enhance project outcomes, stakeholders and project managers must prioritize scheduling and ensure that adequate time is allocated for each phase of the project. Addressing time constraints effectively will not only help in meeting project milestones but also improve the overall success rate of road construction initiatives.

The conclusions drawn from the analysis of scope constraints reveal their critical importance in the successful implementation of road construction projects. With a very strong positive correlation and a high percentage of variance accounted for, it is evident that well-defined project scopes are vital for achieving desired outcomes. To mitigate the risks associated with scope changes and ambiguities, project managers should focus on establishing clear project goals and maintaining effective communication with stakeholders throughout the project lifecycle. By addressing scope constraints proactively, projects are more likely to be completed successfully, on time, and within budget.

The analysis of cost constraints clearly demonstrates their significant impact on the implementation of road construction projects. The strong correlation and the considerable variance attributed to cost management underscore the need for meticulous financial planning and oversight. To improve project success rates, stakeholders must prioritize cost management strategies, ensuring that budgets are adhered to and that resources are allocated efficiently. By effectively addressing cost constraints, project managers can mitigate risks of budget overruns, ultimately leading to successful project delivery and enhanced overall performance in road construction initiatives.

RECOMMENDATIONS

This study makes the following recommendations to enhance the management and implementation of road construction projects, particularly in the context of the Kigali Infrastructure Project. By addressing the challenges identified within the triple constraint's framework, these recommendations aim to improve project efficiency, reduce delays, and optimize resource allocation.

To address time constraints effectively, it is recommended that project managers implement comprehensive scheduling techniques that include the use of project management software to enhance planning and tracking. Employing methodologies such as Critical Path Method (CPM) and Agile project management can help identify key milestones and allocate sufficient time for each task. Furthermore, regular progress monitoring and agile response mechanisms should be established to accommodate unexpected delays, ensuring that projects remain on schedule. Training teams on time management best practices will also equip them with the necessary skills to navigate time constraints more efficiently.

To mitigate scope constraints, it is essential to invest in thorough project planning that includes clear scope definitions and requirements gathering at the project's onset. Implementing a formal change management process will allow for controlled adjustments to the project scope while minimizing disruptions. Regular communication with stakeholders is vital to ensure alignment and manage expectations effectively. Additionally, conducting periodic reviews throughout the project lifecycle can help identify potential scope creep early and provide an opportunity for corrective actions, thus maintaining project focus and integrity.

To enhance cost management in road construction projects, it is recommended that project teams develop detailed budgets that account for all potential expenses, including contingencies for unforeseen costs. Utilizing cost estimation tools and techniques, such as parametric estimating or analogous estimating, can improve budgeting accuracy. Additionally, continuous monitoring of expenditures against the budget throughout the project should be practiced to identify variances promptly. Training staff on financial management principles and fostering a culture of cost awareness will also help ensure that all team members are committed to staying within budget and optimizing resource use.

Suggestions for Further Studies

Future research should explore the impact of external factors, such as political, economic, and environmental influences, on the implementation of road construction projects in Rwanda. While this study focused primarily on time, scope, and cost constraints, external factors can significantly affect project outcomes and decision-making processes. Understanding how these variables interact with project management constraints could provide a more comprehensive framework for assessing project performance. Additionally, qualitative

research methods, such as interviews and focus groups with project stakeholders, could uncover deeper insights into the challenges faced during project implementation and inform strategies for improvement.

Another avenue for further studies could involve a comparative analysis of road construction projects in different regions or countries. This approach would allow researchers to identify best practices and successful strategies employed in diverse contexts. By examining factors such as stakeholder engagement, resource allocation, and technology adoption, future studies could contribute to the development of a more robust project management framework applicable across various settings. Furthermore, longitudinal studies that track the performance of road construction projects over time would yield valuable data on the long-term effects of management strategies and constraints, enriching the existing body of knowledge in project management literature.

REFERENCES

Abdel-Razek, R., El-Diraby, T. E., & Gad, G. (2019). Impact of time constraints on the performance of road construction projects. *Journal of Construction Engineering and Management, 145*(6), 04019032. https://doi.org/10.1061/(ASCE)CO.1943-7862.0001670

Acharya, S., Choi, Y., & Lee, J. (2020). *Time constraints and their impact on the quality of road construction projects*. Transportation Engineering Review, 21(2), 120-134.

Adera, D., Ochieng, P., & Otieno, C. (2019). *Demand for road construction and transportation infrastructure in Kenya: Impacts of population growth and urbanization*. Journal of African Infrastructure, 12(4), 202-215.

Adnan, H., & Hossain, M. (2018). *Challenges in road construction projects: A case study of tight schedules and rushed planning*. Engineering Management Journal, 25(1), 88-101.

Aguinis, H., Edwards, J. R., & Bradley, K. J. (2021). *Improving the reporting of regression analysis in organizational studies: A review and guidelines for the application of multiple regression*. Journal of Organizational Behavior, 42(1), 4-27. https://doi.org/10.1002/job.2463

Ahmed, M., Gao, L., & Li, X. (2020). *Impact of budget constraints on road construction projects in developing economies*. Journal of Construction Management, 34(3), 45-58.

Akinola, O. O., Akinyemi, A. O., & Ojo, O. M. (2022). Examining scope changes and project success in road construction projects: A longitudinal study. *International Journal of Construction Management, 22*(2), 154-168. https://doi.org/10.1080/15623599.2020.1732542

Alhassan, A., Cioffi-Revilla, C., & Crooks, A. T. (2019). *The effects of financial constraints on transportation infrastructure projects: A case study in Ghana*. International Journal of Project Management, 37(5), 830-843.

Alzahrani, J. I., & Emsley, M. W. (2020). *The impact of project management practices on project success in the construction industry*. International Journal of Project Management, 38(5), 317-327. https://doi.org/10.1016/j.ijproman.2020.04.008

Awan, H. M., Hussain, M., & Rizwan, M. (2021). *Stakeholder collaboration and its impact on project success in road construction projects: An empirical study*. Journal of Civil Engineering and Management, 27(6), 380-392. https://doi.org/10.3846/jcem.2021.14017

Bashaasha, B., Sserunkuuma, D., & Nandala, D. (2020). Best practices for scope management in road construction: An empirical study. *International Journal of Project Management, 38*(7), 419-431. https://doi.org/10.1016/j.ijproman.2020.01.002

Chan, D. W. M., & Kumaraswamy, M. M. (2022). Effects of scope constraints on project outcomes in road construction. *Construction Management and Economics, 40*(5), 340-352. https://doi.org/10.1080/01446193.2022.1895500

Chen, L., & Zhang, Q. (2019). *Environmental assessment challenges in road construction projects under time constraints*. Environmental Science and Policy, 58, 72-83.

Chen, X., Liu, Y., & Zhao, P. (2019). *Sustainability in infrastructure projects: Addressing environmental constraints in road construction in China*. Journal of Environmental Management, 45(6), 377-392.

Cooper, D. R., & Schindler, P. S. (2019). *Business research methods* (13th ed.). McGraw-Hill Education.

Copper, D. R., & Schindler, P. S. (2019). *Business research methods* (13th ed.). McGraw-Hill Education.

Creswell, J. W., & Creswell, J. D. (2019). *Research design: Qualitative, quantitative, and mixed methods approaches* (5th ed.). SAGE.

Creswell, J. W., & Creswell, J. D. (2019). *Research design: Qualitative, quantitative, and mixed methods approaches* (5th ed.). Sage Publications.

Diko, R., Kaboza, M., & Olawale, Y. (2019). A review of scope management in road construction projects: Challenges and implications for the future. *International Journal of Construction Project Management, 11*(3), 56-69. https://doi.org/10.1080/21593536.2019.1687092

Feng, X., Yu, H., & Zhao, J. (2020). *Budget limitations and their effects on the long-term resilience of road construction projects*. Journal of Civil Engineering, 56(3), 340-352.

Field, A. (2020). *Discovering statistics using IBM SPSS statistics* (5th ed.). Sage Publications.

Frost, J. (2023). *Correlation in statistics: A beginner's guide*. Statistics by Jim. https://statisticsbyjim.com

Gasana, J., Mutabazi, I., & Nsengiyumva, F. (2019). *Road construction constraints in Rwanda: Budget, time, and technical challenges*. African Journal of Infrastructure, 19(2), 101-113.

Gikunda, M., Kyambadde, M., & Kasozi, D. (2021). The role of digital tools in managing scope changes in road construction projects. *Journal of Engineering, Project, and Production Management, 11*(2), 45-58. https://doi.org/10.2478/jeppm-2021-0020

Goh, M., & Lim, W. (2019). *The impact of time constraints on road construction projects: A study of rushed processes in Malaysia*. Journal of Construction Technology, 18(4), 122-134.

Gwilliam, K., & Shalizi, Z. (2019). *Sub-Saharan Africa's road construction challenges: Constraints and solutions*. Transport Policy Review, 15(2), 99-112.

Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2019). *Multivariate data analysis* (8th ed.). Pearson.

Hancock, D. R., & Algozzine, B. (2020). *Doing case study research: A practical guide for beginners* (3rd ed.). Teachers College Press.

Ika, L. A., Diallo, A., & Thuillier, D. (2022). *Critical success factors for international development projects: A case study approach*. Project Management Journal, 53(4), 91-106. https://doi.org/10.1177/87569728221104676

Joshi, R., & Dikshit, R. (2023). Exploring the effects of scope constraints in the construction industry: A case study of road projects. *Journal of Construction Engineering and Management, 149*(8), 04023025. https://doi.org/10.1061/(ASCE)CO.1943-7862.0002231

Kaboza, M., Muwanga, K., & Kiwanuka, N. (2021). Stakeholder interactions and scope changes in road construction projects. *International Journal of Project Management, 39*(6), 505-517. https://doi.org/10.1016/j.ijproman.2021.02.009

Kadu, A., & Bhandari, M. (2019). *Project completion delays in road construction: Economic and operational impacts in India*. Journal of Project Delays, 22(1), 45-59.

Kaiser, H. F. (2014). An index of factorial simplicity. *Psychometrika, 39*(1), 31-36. https://doi.org/10.1007/BF02289853

Kariuki, C., & Kiilu, M. (2020). *The role of technical expertise in overcoming road construction project constraints in Kenya*. Journal of Infrastructure Development, 14(3), 180-193.

Katende, E., & Kyambadde, M. (2022). Technological solutions to managing scope changes in road construction projects. *Journal of Civil Engineering and Technology, 13*(1), 33-42. https://doi.org/10.9734/jcet/2022/v13i1/202202

Kiringai, J., & Musembi, M. (2019). *Resource allocation challenges in road construction projects in Sub-Saharan Africa: A Kenyan perspective*. Journal of African Development, 10(1), 50-63.

Kothari, C. R. (2019). *Research methodology: Methods and techniques* (4th ed.). New Age International.

Kothari, C. R., & Gaurav, D. (2019). *Research methodology: Methods and techniques* (4th ed.). New Age International.

Laryea, S., & Hughes, W. (2019). Cost management in construction projects: A case study of road construction. *Construction Economics and Building, 19*(2), 14-29. https://doi.org/10.5130/ajceb.v19i2.6789

Li, Q., Huang, G., & Yuan, X. (2019). *Global challenges in road construction and their economic impacts*. Global Transportation Review, 28(4), 102-116.

Li, Z., & Wu, J. (2021). *The interaction of project constraints in road construction: A study of time and budget limitations*. International Journal of Construction Science, 29(2), 128-142.

Liu, J., & He, W. (2019). *Cost constraints and the quality of road construction projects in the United States*. Journal of Transportation Engineering, 46(3), 77-89.

Miles, M. B., & Huberman, A. M. (2019). *Qualitative data analysis: A methods sourcebook* (4th ed.). SAGE.

Morgan, D. L. (2020). *Practical strategies for conducting a successful pilot study*. Sage Publications.

Moyo, F., Nhundu, T., & Phiri, M. (2020). *The impact of resource scarcity on road construction projects in Southern Africa*. South African Journal of Civil Engineering, 48(2), 44-56.

Mugenda, O. M., & Mugenda, A. G. (2019). *Research methods: Quantitative and qualitative approaches* (2nd ed.). Acts Press.

Muliira, J. A., Ocan, A., & Ojeh, V. (2021). The role of local contractors in adapting to scope changes in Ugandan construction projects. *International Journal of Construction Management, 29*(4), 300-313. https://doi.org/10.1080/15623599.2020.1848325

Mutia, L. (2019). *Bureaucratic inefficiencies and technical limitations in road construction in Kenya*. Journal of Infrastructure Research, 21(2), 120-135.

Muwanga, K., & Kiwanuka, N. (2022). The impact of regulatory influences on scope changes in road construction projects. *Construction Management and Economics, 40*(4), 271-285. https://doi.org/10.1080/01446193.2022.1888452

National Institute of Statistics of Rwanda. (2021). *Impact of infrastructure development on urbanization in Kigali: Challenges and opportunities*. Kigali: NISR.

Ngowi, A. B., Shreer, D., & Ochieng, O. (2019). Financial constraints in road construction projects: Exploring cost management practices. *Construction Finance Review, 15*(1), 112-124. https://doi.org/10.1016/j.jcfm.2019.03.004

Ntiamoah, M., Aidoo, P., & Darko, M. (2019). *Environmental and social impact of road construction projects in South Africa: A case study*. Journal of Environmental Policy, 37(5), 200-215.

Nunnally, J. C., & Bernstein, I. H. (2019). *Psychometric theory* (3rd ed.). McGraw-Hill Education.

Ogunlana, S. (2018). *The triple constraints of cost, time, and scope in road construction projects in developing countries*. Construction Management Journal, 19(3), 108-120.

Ogwueleka, T. C. (2020). Scope management in construction projects: Issues and challenges in the African context. *International Journal of Construction Project Management, 12*(4), 29-41. https://doi.org/10.1080/21593536.2020.1865679

Olawale, Y., & Sun, M. (2018). Cost and time constraints in construction projects: A systematic review of the literature. *Construction Management and Economics, 36*(9), 541-554. https://doi.org/10.1080/01446193.2018.1512244

Omony, P., Twaha, R., & Bashaasha, B. (2022). Scope management practices in African road construction: A comparative study. *Journal of Construction and Building Materials, 210*, 132-145. https://doi.org/10.1016/j.jconbuildmat.2020.132145

Palinkas, L. A., Horwitz, S. M., Green, C. A., Wisdom, J. P., Duan, N., & Hoagwood, K. E. (2020). Purposeful sampling for qualitative data collection and analysis in mixed method implementation research. *Administration and Policy in Mental Health and Mental Health Services Research, 42*(5), 533-544. https://doi.org/10.1007/s10488-013-0528-y

Rachmawati, L. P., Sihombing, S., & Edi, S. (2022). *The role of cost constraints and project implementation in the construction industry: Evidence from Indonesia*. Journal of Construction Engineering and Management, 148(4), 04022031. https://doi.org/10.1061/(ASCE)CO.1943-7862.0002047

Republic of Rwanda. (2019). *Annual report on road infrastructure development in Rwanda*. Kigali: Government of Rwanda.

Sekaran, U., & Bougie, R. (2020). *Research methods for business: A skill-building approach* (7th ed.). Wiley.

Shen, L., Zhang, L., & Wang, Y. (2020). *Sustainable road construction in China: Addressing environmental and technical challenges*. Journal of Sustainable Construction, 13(1), 78-92.

Tabachnick, B. G., & Fidell, L. S. (2019). *Using multivariate statistics* (7th ed.). Pearson.

Tavakol, M., & Dennick, R. (2011). Making sense of Cronbach's alpha. *International Journal of Medical Education, 2*, 53-55. https://doi.org/10.5116/ijme.4dfb.8dfd

Trochim, W. M., & Donnelly, J. P. (2019). *Research methods knowledge base* (2nd ed.). Atomic Dog Publishing.

Tuckman, B. W., & Harper, B. E. (2022). *Conducting educational research: A guide to completing a thesis, dissertation, or action research project* (3rd ed.). SAGE.

Twaha, R., Omony, P., & Katende, E. (2021). Comparative analysis of road construction project performance across African countries. *International Journal of Project Management, 39*(5), 405-418. https://doi.org/10.1016/j.ijproman.2021.01.012

Van der Zwaan, B., & Fehr, F. (2020). *The impact of budget constraints on infrastructure projects in Europe*. European Journal of Transport, 45(3), 124-137.

Wang, H., Chen, S., & Zhang, D. (2019). *Road construction project challenges in China: Time and resource constraints*. Journal of Chinese Infrastructure, 12(4), 200-212.

Wang, S., Zhang, S., & Liu, Y. (2023). *Time, scope, and cost management in construction projects: A case study of road infrastructure projects*. Construction Management and Economics, 41(1), 60-77. https://doi.org/10.1080/01446193.2023.1847121

World Bank. (2019). *Rwanda infrastructure development: Challenges and opportunities*. Kigali: World Bank.

World Bank. (2020). *Road construction in Sub-Saharan Africa: Resource challenges and technical solutions*. African Infrastructure Journal, 28(5), 150-163.

Wu, C., Sun, Z., & Chen, J. (2021). *Commodity price fluctuations and their impact on road construction projects in the U.S.*. Journal of Economic Development in Transportation, 14(1), 50-61.

Wu, H., Gao, S., & Li, M. (2019). *Financial constraints and substandard materials in road construction projects in China*. Construction Economics Journal, 11(3), 100-112.

Yamane, T. (1967). *Statistics: An introductory analysis* (2nd ed.). Harper & Row.

Yang, R., Liu, M., & Zhang, X. (2021). *The social and environmental impacts of road construction projects in Sub-Saharan Africa*. Journal of African Infrastructure, 13(2), 88-101.

Zhang, X., Sun, Z., & Yang, T. (2023). *The effects of scope constraints on project performance: A study in the context of road construction projects in China*. International Journal of Project Management, 41(2), 156-167. https://doi.org/10.1016/j.ijproman.2022.11.006

Zietsman, C., Hoffman, J., & Perez, S. (2019). *Resource constraints and environmental regulations in road construction in South Africa*. South African Journal of Construction Management, 14(4), 65-77.