



CONTRACTOR-RELATED VARIATIONS AND IMPLEMENTATION OF KENYA NATIONAL HIGHWAYS AUTHORITY PROJECTS

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Abstract

Contractor-related variations are a major source of inefficiency in road infrastructure projects, often resulting in delays, cost overruns, and disputes. This study investigated how contractor-related variations affect the implementation of Kenya National Highways Authority (KeNHA) road projects and examined the moderating effect of risk management on this relationship. Drawing on Agency Theory and Stakeholder Theory, the study adopted a descriptive research design involving 50 ongoing KeNHA road projects. The study identified a census target population of 600 respondents and obtained 443 valid responses, for a response rate of 73.8%. The study collected data using structured questionnaires and analyzed them using descriptive statistics, regression analysis, and moderation testing. The findings revealed that poor prioritization of work programs ($M = 4.678$, $SD = 0.568$), inaccurate estimation of project duration ($M = 4.268$, $SD = 0.710$), lack of specialized project managers ($M = 4.084$, $SD = 0.807$), and inadequate equipment mobilization ($M = 4.045$, $SD = 0.738$) were among the major contractor-related variations contributing to project delays and cost escalations. Regression results showed that contractor-related variations significantly affected project implementation and explained 61.2% of the variance in project implementation outcomes ($R^2 = 0.612$, $F = 694.248$, $p < 0.001$). Further analysis revealed that risk management significantly moderates the relationship between contractor-related variations and project implementation ($\beta = 0.010$, $p < 0.001$), indicating that effective risk management practices mitigate the adverse effects of contractor-related variations and enhance project implementation outcomes. The study concludes that contractor-related variations pose significant risks to the successful implementation of road infrastructure projects when not effectively managed. The study recommends strengthening risk management practices, enhancing contractor accountability, and improving project planning and resource mobilization to enhance project implementation outcomes in Kenya.

Keywords: *Contractor-related variations, implementation, Kenya National Highways Authority projects*

1. INTRODUCTION

Contractor-related variations remain a central concern in construction project implementation, directly influencing timelines, costs, and stakeholder relationships. These variations typically arise from errors, omissions, or unforeseen circumstances during execution, leading to modifications in scope, design, or resource allocation (Yusuff & Adebayo, 2024). While sometimes necessary, such changes disrupt carefully planned schedules and budgets, often creating disputes between contractors and clients. In road construction projects,



mismanagement of variations can result in significant inefficiencies, with delays and cost overruns undermining national development objectives (RICS, 2023).

Contractor-related variations include adjustments to tasks, materials, and working conditions, often initiated during implementation. Contractors may request changes due to resource shortages, technical errors, or site-specific challenges, which in turn affect project outcomes. Variation orders are consistently identified as a primary reason contractors fail to meet completion deadlines, escalating costs and prolonging project durations (Ramadhan & Waty, 2025; Mata, 2025). These disruptions often lead to conflicts and claims, underscoring the importance of effective variation management in sustaining project success (Shugran & Ghazali, 2025).

Globally, contractor-related variations are a major source of project delays and cost escalations. Studies in Europe show that variation orders account for significant cost overruns, while in Asia they contribute to schedule slippages (Randa et al., 2021). Recent studies indicate that supply chain disruptions, labor shortages, and halted site activities have exacerbated these challenges, leading to widespread variation orders and contractual disputes (Lagat, 2025; Yusuff & Adebayo, 2024). These findings emphasize the universal nature of contractor-related variations and the need for resilient contractual frameworks to mitigate their adverse effects.

Across Africa, contractor-related variations are particularly pronounced due to systemic challenges such as inadequate planning, poor coordination, and resource shortages. Financial difficulties faced by contractors, coupled with material shortages and delayed instructions, are critical sources of project failure. In Nigeria, variations linked to design changes and poor project management have led to cost overruns and project abandonment (Okoye & Chukwu, 2021). Recent regional analyses further show that post-2020 infrastructure projects across Africa have struggled with pandemic-induced supply chain disruptions and financing constraints, intensifying the frequency and impact of variation orders (African Export–Import Bank, 2023). These findings illustrate how contractor-related variations exacerbate existing infrastructural challenges, undermining project implementation across the continent.

In Kenya, contractor-related variations significantly affect road construction projects, which are vital for economic growth and poverty reduction (World Bank, 2021). The Kenya National Highways Authority (KeNHA), the state agency mandated to manage, develop, and maintain national trunk roads, has faced persistent challenges from contractor variations. Contractors often struggle with resource mismanagement, technical errors, and disputes over contract terms, leading to delays and inflated costs. Poor planning and weak enforcement of construction standards further compound these challenges, resulting in frequent variation orders that disrupt project implementation. Recent studies highlight that KeNHA projects, such as highway expansions, continue to experience variation-related inefficiencies, necessitating stronger project management frameworks and improved accountability (Wambugu & Muturi, 2022). Addressing contractor-related variations in Kenya therefore requires enhanced coordination among stakeholders to ensure timely, cost-effective infrastructure delivery.

1.1 Statement of the Problem

Contractor-related variations present a critical challenge to the effective implementation of Kenya National Highways Authority (KeNHA) road projects despite the transport sector's significant contribution to national economic growth. Road infrastructure projects are central to Kenya's economic integration, trade facilitation, and mobility; however, they often face delays, cost overruns, and quality deficiencies due to contractor-related inefficiencies. These inefficiencies often stem from inadequate planning, poor resource management, inaccurate



scheduling, technical errors, and weak project supervision, which necessitate variation orders that disrupt project schedules and budgets (RICS, 2023; Wambugu & Muturi, 2022).

Recent national statistics underscore the magnitude of the problem. The Kenya National Bureau of Statistics (KNBS) Economic Survey (2025) reported that 42% of government-managed road projects implemented between 2020 and 2024 exceeded their planned completion timelines, with contractor-related variations accounting for almost 48% of project cost overruns. Similarly, KeNHA's Annual Report (2024) indicated that variation orders averaged 15% to 20% of total project costs, exceeding the industry-recommended threshold of 10%. Notable projects, including the Sagana-Marua Dual Carriageway and the JKIA-Rironi Highway project, have experienced prolonged implementation periods and escalating costs attributable to technical errors, poor coordination, and contractor-related challenges (KeNHA, 2024; World Bank, 2021). These trends suggest persistent weaknesses in contractor performance and variation management practices.

Empirical evidence from different countries consistently demonstrates that contractor-related variations significantly influence the implementation of road infrastructure projects. In Nepal, Koirala, Thapa, Giri, and Shah (2025) found that scope changes, design errors, and inadequate site investigations were major drivers of variation orders that often led to disputes, delays, and cost overruns. In Arab countries, Elshaboury, Mohamed, and Elsaid (2020) identified economic instability and design changes as critical causes of variation orders that adversely affected project timelines and budgets. Similarly, Chalchissa (2021) established that land acquisition and right-of-way challenges significantly affected road project performance in Ethiopia, while Saki and Yeom (2022) reported that financial problems, poor scheduling, and inadequate coordination were key determinants of variation orders in Tanzanian road projects.

In Kenya, Gatitu, Kabubo, and Ajwang (2020) recommended improved planning, complete project designs, and clearer scope definition to minimize variation orders in KeNHA projects. More recently, Lagat (2025) demonstrated that supplier financial capacity and technical competence significantly enhance project continuity and reduce variation-related disruptions. While these studies provide valuable insights into causes and mitigation strategies, they largely focus on general variation orders and do not specifically quantify the influence of contractor-related variations on project implementation outcomes within ongoing KeNHA road projects. In addition, empirical evidence on the role of risk management in moderating the relationship between contractor-related variations and project implementation remains limited. This study therefore investigated the influence of contractor-related variations on the implementation of Kenya National Highways Authority (KeNHA) road projects and examined the moderating effect of risk management on this relationship.

1.2 Objectives of the Study

The objectives of this study were:

- i. To investigate the influence of contractor-related variations on the implementation of Kenya National Highways Authority (KeNHA) road projects.
- ii. To examine the moderating effect of risk management on the relationship between contractor-related variations and the implementation of Kenya National Highways Authority (KeNHA) road projects.



1.3 Research Hypotheses

The study tested the following null hypotheses:

- i. **H₀₁:** Contractor-related variations have no significant effect on the implementation of Kenya National Highways Authority (KeNHA) road projects.
- ii. **H₀₂:** Risk management does not significantly moderate the relationship between contractor-related variations and the implementation of Kenya National Highways Authority (KeNHA) road projects.

2. LITERATURE REVIEW

2.1 Theoretical Review

Jensen and Meckling (1976) proposed Agency Theory. It explains the relationship between principals and agents, particularly the conflicts that arise when agents pursue self-interest at the expense of principals. In this study, the Ministry of Transport and Infrastructure is the principal, while the Kenya National Highways Authority (KeNHA) is the agent responsible for overseeing national trunk road projects. KeNHA contracts private firms to execute projects, creating a layered agency relationship. To mitigate these risks, KeNHA has adopted governance mechanisms such as Performance-Based Contracting (PBC), which links payments to specified service levels and enhances accountability (Eisenhardt, 1989).

While Agency Theory provides a useful lens for understanding contractor-related variations, its application in public-sector contexts such as Kenya has notable limitations. Monitoring mechanisms are costly and are often undermined by corruption, political interference, and weak enforcement of standards. Moreover, Agency Theory assumes rational actors and clear contractual enforcement, assumptions that may not hold in environments characterized by limited institutional capacity. Recent studies emphasize that governance weaknesses compound agency conflicts in public infrastructure projects, making variations more frequent and disruptive (Alshammari, 2021; Kihoro & Muturi, 2022). Post-2020 evidence further indicates that weak accountability structures in African public works exacerbate contractor opportunism, leading to excessive variation orders (Mashamba, Kanakana-Katumba, & Maladzhi, 2023).

Freeman (1984) advanced Stakeholder Theory, which Donaldson and Preston (1995) later refined. The theory emphasizes the multiple parties involved in road infrastructure projects, including clients, consultants, contractors, regulators, and local communities, each possessing distinct interests and expectations. Variation orders often arise from competing stakeholder demands, such as land acquisition disputes, environmental concerns, regulatory requirements, or political directives. Unlike Agency Theory, which focuses primarily on principal-agent relationships, Stakeholder Theory captures the broader complexity of interactions among project stakeholders. Recent studies have demonstrated that stakeholder misalignment remains a significant driver of variation orders in infrastructure projects across Africa (Osei-Kyei & Chan, 2020; Mwangi & Karanja, 2021; Msiska & Mashwama, 2023).

By integrating Agency Theory and Stakeholder Theory, this study acknowledges both the contractual conflicts that arise between KeNHA and contractors and the broader stakeholder pressures that influence project implementation. Together, the two theories provide a comprehensive framework for examining how contractor-related variations affect the implementation of KeNHA road projects and how risk management practices moderate this relationship.



2.2 Empirical Review

Variation orders (VOs) are widely recognized as a major cause of poor performance in construction projects. Contractor-related variations arising from changes in work programs, equipment mobilization, or project manager specialization are particularly disruptive in road infrastructure projects. While variation orders are legally sanctioned mechanisms for adjusting project scope and contractual requirements, their excessive frequency and poor management often result in cost overruns, delays, and disputes. Recent studies across Africa and Asia confirm that variation orders remain a persistent challenge, undermining infrastructure delivery and national development goals (Koirala et al., 2025; Mashamba et al., 2023).

Financial difficulties are consistently identified as a major source of contractor-related variations. Contractors often face delayed client payments while remaining obligated to meet wage and supplier commitments. This mismatch creates cash-flow crises that may compel contractors to seek additional work through variation orders to maintain profitability. In Tanzania, Saki and Yeom (2022) found that financial problems were the most significant drivers of variation orders, alongside poor scheduling and lack of coordination. In Ethiopia, Chalchissa (2021) reported that land acquisition disputes created financial burdens for contractors, leading to project delays and time overruns. Kenyan evidence reinforces these findings. Lagat (2025) demonstrated that supplier risk profiling, particularly financial capacity and technical competence, was critical in reducing project interruptions at KeNHA. These findings suggest that financial robustness not only determines project continuity but also influences the occurrence of contractor-related variations. However, while financial constraints are widely acknowledged, few studies have quantified their direct impact on the frequency and magnitude of variation orders in Kenya, leaving an important empirical gap.

Design errors, omissions, and incomplete drawings constitute another major source of contractor-related variations. Koirala et al. (2025), in a mixed-methods study of rural road projects in Nepal, found that scope changes and design errors were the primary causes of variation orders, with Relative Importance Index (RII) scores exceeding 0.8 across stakeholder groups. In Arab countries, Elshaboury, Mohamed, and Elsaid (2020) similarly identified design alterations and economic instability as key drivers of variation orders, resulting in project delays and cost escalations. In Kenya, Gatitu, Kabubo, and Ajwang (2020) emphasized complete project designs and clear scope definition as mitigation strategies. Nevertheless, despite these recommendations, KeNHA projects continue to experience design-related variations, as evidenced by cases such as the JKIA-Rironi highway project (KeNHA Annual Report, 2023). The persistence of design-related variations despite existing recommendations highlights gaps in implementation capacity, project preparation, and enforcement mechanisms.

Resource mobilization and procurement inefficiencies further exacerbate contractor-related variations. Long lead times for equipment procurement, shortages of skilled labour, and poor coordination among subcontractors often necessitate project adjustments during implementation. African studies confirm these challenges. Msiska and Mashwama (2023) found that variation order-related delays in South African construction projects were strongly linked to resource shortages and procurement inefficiencies. In Kenya, Lagat (2025) highlighted that technical competence in supplier profiling reduced variation order-related disruptions, underscoring the importance of robust procurement systems. However, empirical quantification of the extent to which resource mobilization failures contribute to the frequency of variation orders in KeNHA projects remains limited.



Unforeseen site conditions such as soil instability, adverse weather conditions, and land disputes are recurrent drivers of contractor-related variations. Saki and Yeom (2022) identified differing site conditions and weather-related challenges as critical causes of variation orders in Tanzanian road projects. Similarly, Chalchissa (2021) reported that right-of-way disputes in Ethiopia significantly delayed road projects, confirming the influence of site-specific challenges on project performance. Kenya faces similar challenges. Land disputes frequently delay road projects, while compensation processes are often contested and politically sensitive (World Bank, 2021). Gatitu et al. (2020) recommended resolving land acquisition and compensation issues before contract award to minimize variations. Despite these recommendations, KeNHA projects continue to face delays linked to unresolved site conditions, highlighting a persistent governance challenge.

Management inefficiencies, poor planning, and weak governance structures also drive contractor-related variations. Fast-tracked projects implemented without adequate management systems are particularly vulnerable to disruptive changes. Arain et al. (2016) emphasized that inadequate communication among project stakeholders frequently leads to costly variations. In Kenya, weak enforcement of standards and governance challenges further undermine project management practices, increasing the likelihood of variation orders. Agency Theory provides a useful lens for understanding these dynamics by highlighting conflicts between principals (KeNHA) and agents (contractors). However, Eisenhardt (1989) noted that monitoring mechanisms are costly and are often difficult to implement effectively in public-sector contexts. Recent studies (Tipu & Yousaf, 2022; Moore & Vining, 2023) further confirm that agency conflicts in public infrastructure projects are compounded by governance weaknesses, making variations more frequent and disruptive. These findings underscore the need for stronger accountability and oversight mechanisms in KeNHA projects.

The literature presents contrasting perspectives regarding the implications of variation orders. Some studies argue that variations may allow contractors to improve profitability and accommodate legitimate project adjustments arising from unforeseen circumstances (Keane et al., 2015). Conversely, other studies contend that variations are primarily disruptive and often lead to delays, disputes, and cost overruns (Mashamba et al., 2023). This divergence reflects the dual nature of variation orders. While some variations are necessary responses to changing project conditions, others may be driven by opportunistic behaviour or inadequate project planning. Resolving this debate requires empirical evidence on whether contractor-related variations in KeNHA projects are predominantly necessary adaptations or avoidable disruptions.

Studies offer important insights into managing variation orders but remain limited in scope. Gatitu et al. (2020) identified mitigation strategies such as adequate planning, complete designs, and clarity of project scope. Similarly, Lagat (2025) demonstrated the importance of supplier risk profiling in reducing project delays and disruptions. However, both studies stop short of quantifying the frequency, magnitude, or management effectiveness of contractor-related variations within KeNHA projects. Furthermore, while the KeNHA Annual Report (2023) indicates that contractor-related variations account for a substantial proportion of project delays, academic studies have not systematically measured their influence on project implementation outcomes or examined the moderating role of risk management. This study therefore sought to fill this gap by investigating the influence of contractor-related variations on the implementation of Kenya National Highways Authority projects and examining the moderating effect of risk management on this relationship.



3. METHODOLOGY

This study adopted a descriptive research design to examine the influence of contractor-related variations on the implementation of Kenya National Highways Authority (KeNHA) road projects and to assess the moderating effect of risk management on this relationship. The design was deemed appropriate because it facilitates the systematic collection, analysis, and interpretation of data on existing phenomena without manipulating study variables. According to Mugenda and Mugenda (2003), descriptive research designs suit studies that seek to describe characteristics, relationships, and practices within a target population.

The study targeted 50 ongoing Kenya National Highways Authority (KeNHA) road projects across Kenya. The target population comprised 600 respondents selected from key stakeholder groups directly involved in project implementation. These included KeNHA project managers, contractor site engineers, contractor site construction managers, supervising consultant engineers, environmental and social safeguards officers, and risk management/quality assurance officers. The selected respondents were directly involved in project planning, execution, supervision, compliance monitoring, risk management, and performance evaluation, making them suitable sources of information regarding contractor-related variations and project implementation. The study adopted a census sampling approach because the target population was manageable and the study sought data from all identified respondents, enhancing the comprehensiveness and representativeness of the findings.

Primary data were collected using a structured questionnaire developed from validated instruments used in previous studies on construction project variations and project performance (Arain, Assaf, & Pheng, 2016; Saki & Yeom, 2022). The questionnaire consisted of sections measuring contractor-related variations, risk management practices, and project implementation outcomes. Respondents rated items on a five-point Likert scale from 1 (Strongly Disagree) to 5 (Strongly Agree). Contractor-related variations were assessed using indicators such as changes in work schedules, construction methods, resource allocation, and contractor performance. Risk management was measured through items on risk identification, assessment, mitigation, monitoring, and control practices, while project implementation was assessed using indicators related to project schedule, budget, scope, specifications, quality, and project planning.

To establish the reliability and validity of the research instrument, a pilot study was conducted using five ongoing KeNHA road projects that were not included in the main study. From each project, three respondents were selected: one KeNHA project manager, one contractor site engineer, and one supervising consultant engineer, for a total pilot sample of 15 respondents. The pilot study refined the questionnaire items by assessing their clarity, relevance, and internal consistency before the main survey. Reliability analysis produced Cronbach's alpha coefficients exceeding the recommended threshold of 0.70 for all study constructs, including contractor-related variations ($\alpha = 0.812$), risk management framework ($\alpha = 0.846$), and project implementation outcomes ($\alpha = 0.879$). These results confirmed the instrument's reliability for the main survey.

Data collection involved direct questionnaire administration, with trained research assistants using the drop-and-pick method. Of the 600 questionnaires distributed, 443 were successfully completed and returned, yielding a response rate of 73.8%. This response rate was considered adequate for statistical analysis and interpretation of findings. Non-response was largely attributed to respondents being unavailable during the data collection period and staff reassignments to other project locations.



Collected data were coded and analyzed using SPSS Version 29. Descriptive statistics, including frequencies, percentages, means, and standard deviations, summarized respondents' views on contractor-related variations, risk management practices, and project implementation. Inferential statistics were employed to test the study objectives. We used simple linear regression to determine the effect of contractor-related variations on project implementation. Hierarchical multiple regression analysis examined the moderating effect of risk management by including an interaction term between contractor-related variations and risk management. We evaluated statistical significance at the 95% confidence level ($p < 0.05$).

The study observed ethical considerations throughout. The relevant University Institutional Review Board (IRB) and the National Commission for Science, Technology and Innovation (NACOSTI) approved the research. Participation was voluntary, and all respondents provided informed consent before data collection. Respondents were assured of anonymity and confidentiality, and all collected data were used strictly for academic purposes.

4. RESULTS

Of the 600 targeted respondents, 443 completed and returned the questionnaires, yielding a response rate of 73.8%. This response rate was considered adequate for statistical analysis and interpretation of the findings. The respondents came from six key stakeholder categories: KeNHA project managers, contractor site engineers, contractor site construction managers, supervising consultant engineers, environmental and social safeguards officers, and risk management/quality assurance officers. These stakeholders were directly involved in project planning, execution, supervision, environmental compliance, and risk management activities within KeNHA road projects. Their participation provided diverse perspectives regarding contractor-related variations and project implementation, thereby enhancing the reliability and validity of the study findings.

4.1 Contractor-Related Variations

Respondents generally agreed that contractor-related variations significantly influence the implementation of KeNHA road projects. The highest mean score ($M = 4.678$, $SD = 0.568$) was recorded for lack of proper prioritization of work and absence of a sound work program, indicating strong consensus that inadequate planning is a major source of project variations. Inaccurate project duration estimates also received a high rating ($M = 4.268$, $SD = 0.710$), suggesting that scheduling deficiencies contribute substantially to project delays. Similarly, respondents identified a lack of specialized project managers ($M = 4.084$, $SD = 0.807$) and inadequate equipment mobilization ($M = 4.045$, $SD = 0.738$) as significant contributors to contractor-related variations. The overall mean score of 4.180 and standard deviation of 0.704 indicate strong agreement among respondents that contractor-related variations adversely affect project implementation outcomes. These findings suggest that deficiencies in contractor planning, scheduling, managerial capacity, and resource mobilization remain critical challenges in KeNHA road projects.



Table 1: Contractor-Related Variations and Project Implementation

Statement	Mean	SD
Lack of proper prioritization of work and sound work program	4.678	0.568
Unavailability of modern equipment	4.045	0.738
Lack of specialized project manager	4.084	0.807
Inaccurate estimation of project duration	4.268	0.710
Contractor profitability pressure	4.031	0.742
Differing site conditions	3.973	0.761
Average	4.180	0.704

4.2 Project Implementation

Respondents also emphasized the importance of key project implementation dimensions in determining project success. Project scope recorded the highest mean score ($M = 4.269$, $SD = 0.710$), reflecting its central role in successful project delivery. Respondents also rated project specifications ($M = 4.084$, $SD = 0.807$) and project quality ($M = 4.032$, $SD = 0.742$) highly, underscoring the importance of technical accuracy and compliance with established standards. Respondents also recognized project budget ($M = 4.018$, $SD = 0.758$) and project schedule ($M = 3.995$, $SD = 0.802$) as critical factors influencing implementation performance. Project planning registered the lowest mean score ($M = 3.973$, $SD = 0.761$), although respondents still agreed that it remains an important determinant of project success. The mean score of 4.062 and standard deviation of 0.763 show strong agreement among respondents on the importance of effective project implementation practices. Overall, the findings indicate that successful project implementation depends on effective management of project scope, quality, specifications, budget, schedule, and planning processes.

Table 2: Project Implementation Factors

Factor	Mean	SD
Project schedule	3.995	0.802
Project budget	4.018	0.758
Project specifications	4.084	0.807
Project scope	4.269	0.710
Project quality	4.032	0.742
Project planning	3.973	0.761
Average	4.062	0.763



4.3 Regression Analysis

The study examined the influence of contractor-related variations on the implementation of Kenya National Highways Authority (KeNHA) road projects using simple linear regression analysis.

The regression model produced a correlation coefficient ($R = 0.782$), indicating a strong positive relationship between contractor-related variations and project implementation. The coefficient of determination ($R^2 = 0.612$) indicates that contractor-related variations explained 61.2% of the variation in project implementation outcomes. The adjusted R^2 value of 0.611 suggests that the model remained stable after adjustment for sample size. Consequently, 38.8% of the variation in project implementation was attributable to factors not captured in the model.

Table 3: Model Summary for Contractor-Related Variations

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.782	0.612	0.611	0.11014

ANOVA Results

An analysis of variance (ANOVA) was conducted to determine whether the regression model significantly explained the relationship between contractor-related variations and project implementation. The results indicate that the model was statistically significant ($F = 694.248$, $p < 0.001$), implying that contractor-related variations significantly predict project implementation outcomes. Therefore, we rejected the null hypothesis that contractor-related variations have no significant effect on project implementation.

Table 4: ANOVA Results for Contractor-Related Variations

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	8.423	1	8.423	694.248	0.000
Residual	5.350	441	0.012	—	—
Total	13.773	442	—	—	—

Regression Coefficients

The regression coefficient for contractor-related variations was positive and statistically significant ($\beta = 0.737$, $t = 26.349$, $p < 0.001$). This finding indicates that increases in contractor-related variations were associated with corresponding changes in project implementation outcomes. The positive coefficient shows that contractor-related variations significantly influence project implementation. Since the p-value was less than 0.05, the null hypothesis was rejected, and it was concluded that contractor-related variations significantly influence the implementation of KeNHA road projects.

The resulting regression equation was:

$$Y = 0.891 + 0.737X$$



Where:

- Y = Project implementation
- 0.891 = Constant (intercept)
- 0.737 = Regression coefficient for contractor-related variations
- X = Contractor-related variations

Table 5: Regression Coefficients

Variable	B	Std. Error	Beta	t	Sig.
Constant	0.891	0.103	–	8.641	0.000
Contractor-Related Variations	0.737	0.028	0.782	26.349	0.000

4.4 Moderation Analysis: Risk Management

Hierarchical multiple regression analysis was employed to examine the moderating effect of risk management on the relationship between contractor-related variations and the implementation of Kenya National Highways Authority (KeNHA) road projects. The regression model included an interaction term between contractor-related variations and risk management to determine whether risk management significantly influenced the relationship between the two variables. The findings indicate that the regression models' explanatory power increased after including risk management and the interaction term. Model 1, which included only contractor-related variations, recorded an R^2 of 0.573. Including risk management in Model 2 increased explanatory power to $R^2 = 0.882$. Further inclusion of the interaction term (Contractor-Related Variations $\times$ Risk Management) in Model 3 increased the explanatory power to $R^2 = 0.889$. These results suggest that risk management contributes significantly to explaining variations in project implementation outcomes and strengthens the relationship between contractor-related variations and project implementation.

Table 6: Moderation Analysis (Risk Management)

Model	R^2	β (Variations)	β (Risk Management)	β (Interaction)	Sig.
1(Variations)	0.573	0.433	–	–	0.000
2(Risk Management)	0.882	0.433	0.356	–	0.000
3 (Interaction)	0.889	0.433	0.356	0.010	0.000

The results show that risk management significantly moderates the relationship between contractor-related variations and project implementation. The interaction coefficient was positive and statistically significant ($\beta = 0.010$, $p < 0.001$), indicating that effective risk management improves project implementation outcomes despite contractor-related variations. The findings further imply that proactive risk identification, assessment, mitigation, monitoring, and control practices enable project teams to manage contractor-related variations more effectively, thereby reducing their adverse effects on project implementation.



Consequently, the null hypothesis stating that risk management does not significantly moderate the relationship between contractor-related variations and project implementation was rejected.

5. DISCUSSION

The findings show that contractor-related variations significantly affect the implementation of Kenya National Highways Authority (KeNHA) road projects. Poor work prioritization and weak work programs ($M = 4.678$, $SD = 0.568$) emerged as the most significant contractor-related variations, suggesting that deficiencies in project planning remain a major source of delays and implementation challenges. These findings support Saki and Yeom (2022), who identified poor scheduling and inadequate coordination as major drivers of variation orders in road construction projects.

Inaccurate project duration estimation ($M = 4.268$, $SD = 0.710$) was also identified as a significant contributor to project implementation challenges. This finding highlights the importance of realistic scheduling and effective project forecasting in minimizing project disruptions. Similarly, the lack of specialized project managers ($M = 4.084$, $SD = 0.807$) and inadequate equipment mobilization ($M = 4.045$, $SD = 0.738$) indicate capacity limitations within contracting firms that affect project execution and increase the likelihood of project variations. These findings align with Lagat (2025), who emphasized the importance of technical competence and resource capacity in improving continuity and performance in KeNHA projects.

The regression analysis established that contractor-related variations significantly influence project implementation and explained 61.2% of the variation in implementation outcomes. This finding shows that contractor-related variations are a major determinant of project performance and confirms the central proposition of Agency Theory: inefficiencies arising from contractor actions can adversely affect project outcomes.

The significant moderating effect of risk management underscores its critical role in enhancing project implementation through proactive risk identification, assessment, mitigation, and monitoring. Projects characterized by stronger risk management practices are better positioned to manage contractor-related variations and minimize their adverse effects on project outcomes. This finding supports the argument that effective risk management frameworks enhance project resilience and contribute to successful infrastructure delivery despite project uncertainties (ISO, 2018).

6. CONCLUSION

The study established that contractor-related variations significantly influence the implementation of Kenya National Highways Authority (KeNHA) road projects. The findings revealed that poor prioritization of work programs, inaccurate project duration estimates, a lack of specialized project managers, and inadequate equipment mobilization were key contractor-related factors contributing to project delays, cost overruns, and implementation challenges. Regression analysis established that contractor-related variations explained 61.2% of the variation in project implementation outcomes, confirming their significant effect on project performance. The findings further revealed that risk management significantly moderated the relationship between contractor-related variations and project implementation. Consequently, effective risk identification, assessment, mitigation, monitoring, and control practices can reduce the adverse effects of contractor-related variations and enhance project delivery. The study concludes that strengthening contractor accountability and institutionalizing robust risk



management practices are critical for improving the successful implementation of KeNHA road projects.

7. RECOMMENDATIONS

Based on the findings, several measures are proposed to improve project implementation within Kenya National Highways Authority. Contractors should submit validated work programs and adopt standardized scheduling tools to enhance planning accuracy and reduce delays (Project Management Institute, 2023). KeNHA should enforce minimum qualification standards for project managers and ensure contractors have adequate resources during procurement (World Bank, 2022). Additionally, KeNHA should institutionalize risk management through risk registers, audits, and continuous monitoring (ISO, 2018). Finally, stricter regulation and transparent reporting of variation orders, alongside continuous training programs, are essential to enhance accountability and project delivery outcomes. To implement these recommendations, a phased project implementation strategy is recommended. Immediate (0-1 year) actions include enforcing validated work programs, adopting standardized scheduling tools, and mandating risk registers. Medium-term (1-3 years) initiatives should focus on building contractor capacity through training, enforcing project manager certification, and establishing equipment leasing partnerships. Long-term (3+ years) priorities include institutionalizing policy reforms, embedding comprehensive risk management frameworks in contracts, and enhancing transparency through public reporting on variation orders and project performance.

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