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Effect of Risk Mitigation on Performance of Water and Sewerage Projects in Kenya: A Case Study of Nairobi City Water And Sewerage Company

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Abstract
Many infrastructural projects encounter issues due to massive fiscal shortfalls, unrealistic timelines, and poor planning, resulting in incomplete or poorly implemented projects. Even though there are studies exploring influence of risk management practices, empirical gaps exist in exploring the role of risk mitigation in projects. The purpose of the study was to determine the influence of risk mitigation on performance of water and sewerage projects in Nairobi County, Kenya. A correlational research design was used, whereby data were collected through online questionnaires. The study used a target population of 210 participants selected through stratified random sampling from 45 water and sewerage projects. Using the Yamane formula, the population was reduced to 138. Data were then analyzed and interpreted using the Statistical Package for the Social Sciences (SPSS) Version 28 for descriptive and inferential analyses. The multiple regression results indicated that risk mitigation was positively associated with project performance, with a coefficient value for risk mitigation, $\beta = 0.228$, $p > 0.002$. However, the findings showed that even though the relationship between risk mitigation and project performance was positive, it was statistically insignificant as the p-value exceeded 0.01. The study concludes that risk mitigation positively influenced the project performance of water and sewerage projects. This means that the relationship was not sufficiently strong to conclude that risk mitigation significantly influences project performance. The study recommends that future studies should investigate the relationship between risk mitigation and project performance in different regions, project categories, and sectors to establish if the findings are consistent.

Keywords: *risk mitigation, risk reduction, risk acceptance, risk transfer, risk avoidance.*

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I. Introduction

1.1 Background to the Study

According to the Project Management Body of Knowledge Guideline (PMBOK), a project is a temporary endeavor that aims to deliver specific objectives through a unique plan (Amaro & Domingues, 2023). Project management involves applying techniques, tools, and skills to ensure project requirements and objectives are met (Amaro & Domingues, 2023). According to Hubbard (2020), project management principles such as planning, execution, and monitoring, as well as risk management practices, are crucial to project success. In today's dynamic, fast-moving business environment, most projects face risks, so project managers must understand and apply risk management principles. Effective project management helps a firm navigate this dynamic environment by applying risk management principles, such as risk mitigation, to reduce the severity and likelihood of risks.

Many water and sewerage projects worldwide remain incomplete, stalled, abandoned, or ineffective, indicating poor project performance. According to findings by Hassanen and Abdelalim (2022), this is mainly caused by poor risk management practices, massive fiscal shortfalls, unrealistic timelines, and poor planning. For instance, Qureshi and Kim (2002) report that Pakistan faces severe water and sanitation challenges, with only 47% of the population having access to safe water and over 92% of sewage untreated. National sanitation projects, such as the Karachi Bulk Water Supply and the Greater Karachi Sewerage Plan, have experienced significant cost overruns and project delays. According to Qureshi and Kim (2002), the Karachi Water Supply project, which began in 2003, was estimated to cost Rs 25.6 billion and was scheduled for completion by mid-2019. However, severe financial constraints stalled the project for over two decades, and the revised cost rose to approximately Rs 150 billion (Qureshi & Kim, 2002).

Poor project performance in the water and sewerage sector is also a major concern in African nations. For example, a study by Ntirenganya (2023) finds that most water and drainage projects in Rwanda face completion delays because they fail to establish a comprehensive risk management plan during the first phase of

project planning. According to the Auditor General, 55 government-funded water project contracts estimated at RWF 644 billion experienced delays in 2022, resulting in doubled expenditure (Ntirenganya, 2023). Poor project implementation in Rwanda was primarily caused by a lack of structured, defined risk assessment tools to measure the likelihood and impact of risks, since 80% of project managers rely on assumptions (Ntirenganya, 2023).

In Kenya, the same issues persist, hindering the successful implementation of water and sewerage projects across counties. For instance, in Nairobi County, of the ten water projects in 2022 with an estimated budget of Ksh. 6.3 billion, three programs costing Ksh. 2.3 billion had progressed well, whereas seven projects costing Ksh. 4 billion were not fully completed, resulting in an alarming completion rate of 51% (Nyarangi, 2025). Given the persistent poor performance of water and sewerage projects globally, regionally, and locally, this study examined how risk mitigation can enhance project performance and ensure projects are completed within the desired timeframe, budget, and scope.

Essentially, risk mitigation is a core component of risk management in every project. According to Hassanen and Abdelalim (2022), the risk mitigation process involves devising tailored plans to mitigate identified and assessed risks, minimizing their impact and likelihood of occurrence. Effective risk mitigation significantly reduces the rate of project failure by enabling project managers to manage uncertainty, deliver predictable outcomes, control resources, and improve performance. Suvvari (2020) highlights four main risk-mitigation strategies: reduction, transfer, acceptance, and avoidance. Risk avoidance entails eliminating risk by refraining from participating in the situation or activity that leads to it (Saglam et al., 2021). This strategy is often used for projects with high-impact risks where the mitigation expenses outweigh the overall benefits. Risk reduction entails minimizing a risk's effects or likelihood through safeguards and procedures, and is commonly used for medium risks. Risk transference shifts the risk to another party, while risk acceptance acknowledges the risk and accepts its potential impacts without mitigation (Landoll, 2021). Depending on the project type, the identified threats, their effects, and their likelihood of occurrence, these four strategies help ensure seamless project execution.

1.2 Problem Statement

Access to water and sewerage sanitation services is a basic right in Kenya for both domestic and commercial use. Driven by the need to serve a growing population, especially in informal settlements, Nairobi County has been a major hub for water and sewerage projects compared to other devolved units (Advani, 2019). Nairobi County has registered several successful water and sewerage projects. For instance, the Kiamaiko sewer rehabilitation project, completed in December 2024, involved laying about 2,200 m of sewer pipeline to upgrade the sewer network in the area, ultimately improving sanitation (Nairobi City Council, 2024). However, the commissioning date has not been publicly announced, reflecting delays and stagnation in many water and sewerage projects across the county.

Despite concerted efforts by all players to implement the water and sewerage projects in Nairobi County, there are still many delayed or poorly implemented projects, or projects that are still under construction with massive cost overruns (Maina & Mungai, 2023). For example, in Nairobi County, only 5% of sewage is effectively treated because inadequate and failed projects have prevented the establishment of wastewater treatment programs and sewerage systems (Mutia, 2022). Another report by the Nairobi City Council (2024), only 1% of residents in Mukuru kwa Reuben and Mukuru Kwa Njenga have access to private toilets; half of households rely on pit latrines, while the majority defecate in the open, which is unsafe and undignified. In light of this, this study examined how risk mitigation influenced the performance of water and sewerage projects in the county.

Although existing studies explore the role of risk mitigation strategies in project performance, this study addressed several empirical and methodological gaps. For example, studies such as those by Maina and Mungai (2023) and Munyugi and Nteere (2024) employ cross-sectional and descriptive research methodologies, creating a methodological gap. This study addressed this gap by using a correlational research design. In addition, the study focused on risk mitigation, exploring whether and how principles such as risk reduction, acceptance, avoidance, and transfer affect the performance of water and sewerage projects.

1.3 Main Objective of the Study

The study's primary objective was to examine the effect of risk mitigation on performance of water and sewerage projects in Nairobi County.

1.4 Significance of the Study

The study’s findings benefit various stakeholders, including project leaders and managers, project team members, and external shareholders like donors. Project managers can use the findings to make informed decisions on procurement, resource allocation, project scheduling, and contingency budgeting. This will prevent delays, reduce unexpected costs, and minimize project disruption. The findings will help external project stakeholders, such as donors, government bodies, and other stakeholders, make decisions about emerging risks. Existing investors and those considering investing in a new project will find this research useful, as it will help them assess

whether project resources are used efficiently and protected through appropriate risk-mitigation strategies. This information informs funding decisions and strengthens financial oversight, promoting more project investments.

1.5 Scope of the Study

The study used contingency theory as the anchoring theoretical framework. The study employed a correlational research design, using surveys to collect data and statistical methods to quantify results. The target population comprised 45 water and sewerage projects. The unit of observation was 210 participants. Stratified sampling helped narrow the project pool, from which participants were selected using simple random sampling. The study sample size was 138, based on the Yamane formula. The study period was from July 2025 to October 2026.

II. Literature Review

2.1 Theoretical Literature

First proposed by Fred Fiedler in 1964, contingency theory offers an alternative framework for anticipating risk events and their impacts (Otley, 2016). The theory focuses on making decisions and taking actions that mitigate or reduce the negative impacts of identified risks, tailored to the situation (Omazic et al., 2023). In water and sewerage projects, risks may differ from those in other infrastructure projects and from one water and sewerage project to another. For example, the appropriate mitigation strategy for rising construction material costs may differ from the initially proposed budget or past projects, requiring project managers to address contractor delays and equipment failure. Therefore, contingency theory proposes matching risk mitigation responses to the specific circumstances and risk types identified for a given project.

Contingency theory informs risk mitigation strategies, which involve avoiding, transferring, mitigating, or accepting risks. The theory holds that no single risk mitigation technique is best; instead, the right strategies depend on the project's specific nature (Shala et al., 2021). For instance, in low-cost or small projects, teams often adopt the acceptance method, as the costs of avoidance and transfer strategies may outweigh the risks (Omazic et al., 2023). Conversely, mega projects often employ transfer mitigation methods, as extended exposure to the risk may have adverse impacts. Additionally, in the context of budgets, contingency theory posits that project managers should consider having flexible financial controls and procurement strategies, as well as contingency reserves. This ensures projects have a backup plan to access essential resources amid unprecedented shortages or supply disruptions. In terms of time, contingency theory suggests that project leaders should build flexibility into schedules when developing risk-mitigation responses. This helps ensure the project is delivered within a realistic timeline, improving deliverables. Contingency theory therefore supports the idea that selecting and adapting risk mitigation measures appropriately can enhance project performance.

2.2 Empirical Literature Review

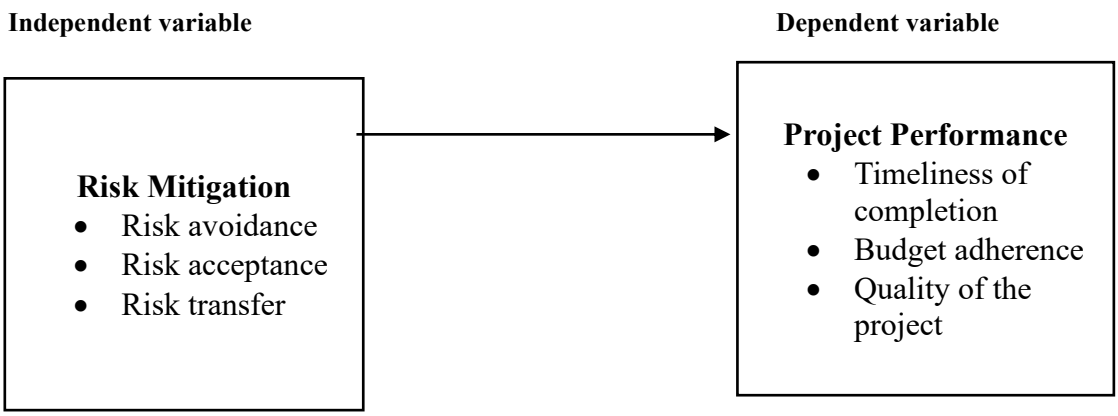
In a study by Oruru and Juma (2022), the authors examined the influence of risk response and mitigation strategies on the success of constituency-funded infrastructure projects in Nyamira County, Kenya. A descriptive research method was used, with a target population of 719 respondents selected from 216 county infrastructure projects. The sample entails 432 project committee members, 15 consultants, 216 contractors, and 12 NGO staff. The findings showed that the four risk mitigation strategies, risk avoidance, transfer, acceptance, and reduction, had a positive and significant effect on completing the selected infrastructure projects. The authors recommended conducting more studies across specific projects in Nyamira County to compare the impact of risk mitigation strategies. This highlights a contextual gap that the study aims to fill by focusing on the water and sewage company.

Kavuli and Kirui (2020) explored the effects of risk mitigation practices and the success of women's group projects within Kitui County, Kenya. Because most projects face challenges such as inefficiency, cost overruns, and delays in meeting objectives, the study aimed to assess whether risk mitigation practices affect project completion rates. The study used a descriptive approach and was anchored in agency theory and risk management theory. From 583 employees, the study used probability sampling to select 175 participants. Data were then analyzed using SPSS, which revealed that risk monitoring, including avoidance, transfer, reduction, and acceptance, significantly and positively influences women’s group projects. The authors emphasize the need to choose the most suitable risk mitigation strategy based on the type of risks.

Nduwayezu and Hakizimimana (2024) investigated the effect of risk management strategies on the success of community-based projects in Burera District, Rwanda. Data were collected from 177 participants selected via simple random sampling across 29 NGOs. This was achieved through questionnaires. Secondary information was also collected through interviews and reviews. The study indicated a strong positive relation between planning, early risk identification, and project completion. However, risk mitigation showed a weaker positive correlation with an average of 0.430. This suggests that although risk mitigation strategies affect community project success, they have less influence than the other practices.

2.3 Conceptual Framework

A conceptual framework presents a visual map showing how two or more variables relate to each other. The figure below shows the link between risk identification (predictor) and project performance (outcome).



III. Methodology

The study used a correlational research design to examine the relationship between risk assessment and performance of water and sewerage projects undertaken by the Nairobi City Water and Sewerage Company. This research design was suitable for identifying the association and strength between the two constructs. The study's target population was 210 participants, selected through random sampling from 45 projects. The participants included 45 project managers, 30 site managers, 25 project committee members, 50 contractors, and 60 technical staff. The respondents were targeted because they all have responsibilities in ensuring project completion. Participants were randomly selected to ensure representation of all staff with different experience and expertise in the water and sewage projects. The Yamane Taro formula was used to determine the sample size, which was narrowed down from 210 to 138 respondents.

To collect data, the study used structured questionnaires, which were ideal since they allowed collection of both qualitative and quantitative data. The questionnaires were distributed online through Google Forms to reach all project stakeholders in different regions. Before the main study, a pilot study involving 14 respondents was conducted. These participants were excluded from the main study to minimize bias. Pilot testing was conducted in Mathare Sub-county. The questionnaire items also underwent a reliability test using Cronbach's alpha; values above 0.7 were considered to have higher internal consistency and were therefore retained for the study. Content validity was also assessed by incorporating the supervisor's feedback. Construct validity was also assessed using the Kaiser-Meyer-Olkin (KMO) values, with a cutoff of 0.5. This means that items with values above 0.5 were considered valid, whereas those below the threshold were invalid. Both construct validity and reliability tests were done using SPSS software Version 28.

IV. Findings and Discussions

4.1 Response Rate

Of the 138 questionnaires distributed digitally, only 135 were returned with complete, unambiguous responses. Despite the high response rate of 97.8%, the study may have experienced some limitations. For instance, self-reported data may have introduced response or social desirability bias, while the cross-sectional design limited the ability to establish changes over time or strong causal relationships.

4.2 Reliability Test

The results showed that risk mitigation had a good internal consistency. The Cronbach's Alpha value was 0.804, exceeding the 0.70 threshold. The score was above 0.8, indicating it was ideal for assessing the influence of risk mitigation on the performance of water and sewerage projects.

4.3 Bio Data Analysis

The study captured respondents' gender to determine the representation of male and female respondents, thus ensuring a balanced view and identifying any potential gender-based variations in responses. The results showed that 61.5% were male and 38.5% were female. This gender difference slightly interfered with the results since the findings reflected more nuances from the males than the females, creating an imbalance.

The respondents' ages were also analyzed to establish the generational composition of the respondents. The findings showed that 38 participants (28.1%) were between 21 and 30 years, 32 (23.7%) were between 31 and 40 years, 17 (12.6%) were between 41 and 50 years, 20 (14.8%) were between 51 and 60 years, and 28

(20.7%) were over 60 years. The age distribution shows a diverse representation across all age brackets. However, there is a stronger representation of young adults aged 21 to 30, suggesting early-career personnel in technical project management roles.

The study also assessed respondents' education level. The results showed that 36 (26.7%) had a college diploma, 68 (50.4%) had a bachelor's degree, 21 (15.6%) had a master's degree, and 10 (7.4%) had a doctorate. Individuals with a bachelor's degree were the dominant group, suggesting that most participants have a solid academic background and are qualified for technical and operational roles in the projects.

Lastly, the findings also examined the time spent on the projects for each participant. 8 participants spent less than a year, 20 spent between 1 and 3 years, 59, who were the majority, spent between 4 and 6 years, followed by 48 who spent over 6 years. A small proportion of respondents (28) had been involved in the projects for less than 3 years, suggesting stagnation in the completion of water and sewerage projects.

4.4 Descriptive Statistics

Risk response plans were designed based on the identified risks

46% of the respondents agreed that risk response strategies were designed based on the likelihood of the identified risks, with a mean of 3.02 and a standard deviation of 1.46. The relatively high standard deviation suggests variable responses, possibly because some respondents used structured mitigation practices while others did not. The findings, along with those of Nyamwange and Kyule (2023), highlight that most infrastructure projects perform poorly because they lack a standardized, formal risk mitigation framework that aligns with the risks identified by their likelihood and impact. These findings emphasize the need to implement or strengthen standardized risk mitigation frameworks to improve effectiveness across all projects and departments.

Appropriate risk response plans were chosen

Over half of the respondents 56.3% disagreed that appropriate risk response measures were chosen to mitigate the risks, with a mean of 2.60 and a standard deviation of 1.35. This statement shows that most respondents believe that, even though the correct risks may have been identified, the chosen mitigation actions were either misaligned or inadequate. Bello (2025) states that the disconnect between risk assessment and risk response strategies is common in projects or firms with poor stakeholder consultation, limited expertise, resource constraints, and poor risk prioritization.

High-level risks were transferred

40% disagreed that high risks were transferred to third parties, suggesting minimal consultation with highly skilled personnel, with a mean score of 3.13 and a standard deviation of 1.22. Respondents believe there is limited engagement and consultation with external professionals, especially for high-severity risks, which, according to Kadala (2024), may compromise the quality of risk handling, resulting in poor project performance.

Low-level risks were deliberately monitored

60% also disagreed that low risks were deliberately monitored throughout, with a mean of 2.47 and a standard deviation of 1.47. The findings show that risk acceptance is not applied strategically, suggesting that low risks are more likely to be neglected than monitored, thereby undermining the effectiveness of the risk management cycle. The findings reiterate those of Mbuli and Mungai (2024), which emphasize the need for a clear, robust framework and indicators that track accepted risk to enhance visibility and improve documentation practices.

Project teams had clear responsibilities in mitigating risks

Almost half of the respondents (48.5%) also disagreed that all team members had clear responsibilities for their roles in risk mitigation. A mean of 2.82 and a standard deviation of 1.51 suggest poor communication across team members. The mean indicates that most respondents leaned toward disagreement, with a relatively high standard deviation, suggesting significant inconsistency in communicating roles in risk mitigation. The lack of clearly assigned ownership of risks is likely to result in overlaps, gaps, and duplication of mitigation activities, wasting the project's resources, time, and labor. In his findings, Kadala (2024) recommends implementing a formal risk management structure with distinct communication channels to help project leaders communicate and train every team member on their responsibilities in risk mitigation.

Mitigation plans were regularly reviewed

A significant number (66.7%) agreed that mitigation responses were often adjusted based on risk dynamics, with a high mean of 3.88. The results suggest that most water and sewerage projects within the company are flexible, dynamic, and responsive in managing risks, and that they perceive risk management as a continuous process. Lastly, 49.6% disagreed that the risk mitigation process prevented numerous project disruptions, with a mean of 2.69 and a standard deviation of 1.49. The relatively high standard deviation suggests considerable differences in opinion. This implies a gap between risk identification and assessment and the outcomes of risk control. The findings are similar to those of Mbuli and Mungai (2024), who found that weak or inappropriate risk response measures often fail to address the identified risks, resulting in poor project or organizational performance.

4.5 Correlation Analysis

Table 1: Correlation analysis results

		Risk mitigation	Performance
	N	135	135
Risk mitigation	Pearson Correlation	1	.323***
	Sig. (2-tailed)		<.001
	N	135	135
Performance	Pearson Correlation	.323***	1
	Sig. (2-tailed)	<.001	
	N	135	135

***. Correlation at 0.001(2-tailed)

Risk mitigation shows a correlation coefficient of r = 0.323 ($p < 0.01$) at the 1% significance level. The values indicate a moderate positive relationship between the two variables, suggesting that risk mitigation directly influences project performance. This aligns with Ahmed (2017), who suggests that effective risk mitigation focuses on eliminating and minimizing risks, reducing their negative impacts on project costs, quality, and timelines, and ensuring better performance.

4.6 Regression Analysis

Table 2: Model summary

Model	R	R Square	Adjusted R-Square	Std. Error of the Estimate
3	0.580a	0.340	0.320	0.760

a. Predictors: (Constant), risk mitigation.

The correlation coefficient (R=0.580) shows a moderate positive relationship between risk mitigation and project performance, suggesting that improvements in risk mitigation are associated with similar improvements in project performance. The coefficient of determination (R-squared = 0.340) indicates that 34% of the variation in project performance is attributable to risk mitigation. The remaining 66% is caused by other variables or factors excluded from the model.

Table 3: Regression of coefficient results

Variable	B	Std. Error	Beta	T	Sig
Constant	1.02	0.43	0.000	2.37	0.022
Risk mitigation	0.64	0.12	0.58	5.35	0.000

Y= (project performance) X_3=risk mitigation Constant= 1.02 Coefficient=0.64

$Y= 1.02+0.64X_3 +\epsilon$

From the table above, risk mitigation has a moderate-to-strong positive effect on project performance. This could mean that the effectiveness of risk mitigation strategies, including avoidance, transfer, reduction, and acceptance, depends on proper risk identification and accurate assessment.

Table 4: ANOVA Analysis

Model		Sum of Squares	Df	Mean Square	F	Sig.
	Regression	16.32	1	16.32	28.64	.001[b]
1	Residual	31.98	54	0.59		
	Total	48.30	55			

a. Dependent Variable: Project Performance
b. Predictors: (Constant), Risk mitigation.

The ANOVA results above indicate that the model is significant, confirming that risk mitigation practices influence performance. However, the influence is statistically significant but not substantively strong. The regression sum of squares of 16.32 indicates that 16.32 units of the total variation in project performance are attributed to risk monitoring. In addition, the residual sum of squares of 31.98 represents the portion of variation in project performance attributed to other factors. The ANOVA findings confirm that the regression model is statistically acceptable and adequately explains the relationship between risk mitigation and project performance,

supporting Kavuli and Karuri's (2020) argument that risk mitigation plans should be adopted and implemented based on assessed risks to enhance project outcomes.

V. Conclusion and Recommendations

5.1 Conclusion

The study concluded that risk mitigation had a positive and statistically significant influence on performance of water and sewerage projects in Nairobi County. With the correlation coefficient value being $r=0.323$, $p<0.01$, it indicates a positive association between the variables. This suggests that changes or improvements in risk mitigation measures tend to directly correspond to improved project performance. These findings therefore stress the need to implement suitable risk response measures to tackle the identified and assessed risks to minimize the potential effects on project performance. Despite the positive and significant relationship, the study revealed several gaps that could be addressed in future studies. For instance, the findings showed that most risk response measures were misaligned with identified risks, as well as a lack of clear assignment of responsibilities among team members. This weakened risk response impacts, exposing the projects to avoidable disruptions, cost overruns, and implementation delays.

5.2 Recommendations

One of the recommendations for risk mitigation strategies in Nairobi City Water and Sewerage Company is to strengthen the link between risk assessment and risk mitigation practices. The results showed that the chosen mitigation practices were ineffective, suggesting that the company poorly translated assessed risks into responses. Thus, the study recommends that the company develop responses that are directly tied to the identified and assessed risks to improve the effectiveness and relevance of the risk mitigation process. In addition, the company should establish reliable monitoring systems for both low- and high-risk activities. The results showed that the company neglected most low-risk projects, which could lead to cumulative, damaging impacts over time. Thus, the company should establish a tiered, reliable evaluation system that ensures high-risk areas receive frequent, intensive monitoring and that low-risk areas are periodically reviewed. A balanced, low- and high-risk monitoring system prevents risks from escalating, thereby promoting an effective risk mitigation process.

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