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Assessing the Influence of Project Risk Management Practices on Quality Performance in Water Reticulation Projects: A Case Study of SWSC in Choma District of Southern Province

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Abstract

Water reticulation projects are essential for providing reliable water services and supporting public health and community development. However, their quality performance can be affected by risks related to technical requirements, procurement, finance, contractor performance, environmental conditions, and stakeholder expectations. This study therefore assessed the influence of project risk management practices on the quality performance of water reticulation projects undertaken by Southern Water and Sanitation Company (SWSC) in Choma District, focusing on risk identification, risk assessment, risk response, and risk monitoring and control. The study used an exploratory case study design and adopted a mixed methods approach to collect primary data. STATA was used for both data entry and statistical analysis, while Microsoft Excel 365 was employed to present descriptive statistics through graphical representations. For inferential analysis, Multivariable logistic regression analysis was conducted to examine associations between categorical variables. The findings show that SWSC used several project risk management practices, with risk monitoring being the most frequently conducted activity (31.5%), followed by risk identification (26.1%) and risk response planning (22.8%). Risks were mainly identified during project planning and implementation, using site inspections, team meetings, and risk registers, with technical risks being the most common. Risk management was viewed as a shared responsibility, while risk registers were the main document used and risk mitigation was the most frequently applied strategy. The findings further show that risk response planning and risk monitoring were significantly associated with good or excellent quality performance, with respondents reporting risk response planning having higher odds of reporting good or excellent quality (OR = 6.857, p = 0.003) and risk monitoring also showing a significant association (OR = 4.571, p = 0.024). Risk identification had a positive but statistically insignificant association (OR = 2.444, p = 0.184), indicating that risk response planning and monitoring were the practices most strongly associated with reported quality performance. The study concludes that project risk management practices contribute to the quality performance of water reticulation projects implemented by SWSC in Choma District, with risk response planning and monitoring showing the strongest influence on quality. The study therefore recommends strengthening risk monitoring and response planning, technical supervision, procurement and material quality controls, staff training, communication, resource allocation, and integration of risk and quality management.

Keywords: Project Risk Management Practices, Quality Performance, Water Reticulation Projects

1. Introduction

1.1 Background

Water reticulation projects are an important component of infrastructure development because they provide systems for the collection, transmission, storage and distribution of water to households, institutions, commercial establishments and industries (Naqash, 2023). The successful delivery of these projects depends not only on the availability of financial and technical resources but also on the ability of project teams to identify, assess and manage risks throughout the project life cycle (Saurav, 2025) [28]. In water reticulation projects, risks may arise from design changes, poor-quality materials, contractor performance,

delays in procurement, financial constraints, environmental conditions, labour shortages, inadequate supervision and unforeseen ground conditions (Gondaliya, 2025).

Globally, project risk management has become an established part of project management practice as infrastructure projects have become more complex and exposed to financial, technical, environmental and operational uncertainties (Rasul, 2025). International project management perspectives increasingly emphasise risk identification, risk analysis, risk response and continuous risk monitoring rather than treating risk as an issue that is addressed only after problems occur (Rahi, 2021). Water infrastructure projects are particularly exposed to risks because they involve multiple stakeholders, underground construction, environmental considerations, public procurement processes and long implementation periods (Aiyetan, 2021).

In sub-Saharan Africa, water infrastructure development has been affected by rapid population growth, urbanisation, limited financial resources, ageing infrastructure and gaps in technical capacity (Nyika, 2023). These conditions increase the complexity of water reticulation projects and expose implementing organisations to a range of project risks. Delays in procurement, inadequate project supervision, contractor capacity constraints, changes in project scope and shortages of construction materials can affect project implementation (Duale, 2025).

In Zambia, access to safe and reliable water supply remains an important development and public service issue. The country has continued to invest in water supply infrastructure to respond to population growth, urban expansion and increasing demand for water services (Nkolola, 2025). Water supply and sanitation development is guided by national policies and legislation that establish institutional responsibilities and standards for the provision and regulation of water and sanitation services (Mwale, 2025). The Water Supply and Sanitation Act No. 28 of 1997 established the framework for commercialisation and regulation of water supply and sanitation services, while subsequent reforms strengthened the role of Commercial Water Supply and Sanitation Companies in service provision (Mwale, 2026).

The relationship between project risk management and quality performance has generated different perspectives. One perspective holds that risk management improves project quality by allowing potential problems to be identified before they affect project outputs (Zang, 2022). Another perspective is that risk management can become ineffective where it is treated as a compliance exercise rather than an active management process. The existence of risk registers, meetings and reporting procedures does not necessarily guarantee effective risk control if identified risks are not analysed properly, assigned to responsible parties and monitored until resolution (Oguzie, 2025).

This creates the need to examine not only whether risk management practices exist, but also how they influence the quality of project implementation. A case study of Southern Water and Sanitation Company (SWSC) in Choma District provides an opportunity to examine this relationship within a specific Zambian water utility and project environment. The study can therefore contribute to the understanding of risk management practices in water reticulation projects and provide evidence that may support improved project planning, implementation, supervision and quality control in Zambia's water supply sector.

1.2 Statement of the problem

More than 2 billion people worldwide lack access to safely managed drinking water, while over 4 billion people do not have access to safely managed sanitation services. Furthermore, approximately 3 billion people lack access to basic handwashing facilities, highlighting persistent global gaps in water, sanitation, and hygiene (WASH) services (Dhiman, 2026). Zambia is estimated to require approximately US$5.7 billion to implement its Water Investment Programme, which seeks to strengthen and expand WASH infrastructure nationwide. In addition, the National Urban Water Supply and Sanitation Programme estimates that about US$4 billion will be needed to meet urban water supply and sanitation investment requirements by 2030 (Hutton, 2026). In Zambia, water service challenges are evident in urban, peri-urban and rural areas, where limited infrastructure and growing demand increase the need for effective water reticulation projects. At the national level, audit evidence reports delayed and incomplete water reticulation projects, suggesting weaknesses in areas such as planning, contractor performance, supervision, procurement and risk management (Phiri, 2026). However, there is limited empirical evidence on how project risk management practices specifically influence the quality performance of water reticulation projects implemented by Southern Water and Sanitation Company (SWSC) in Choma District. Therefore, this study is necessary to assess the influence of project risk management practices on quality performance in SWSC water reticulation projects in Choma District and provide evidence that can support improved project implementation, supervision and quality outcomes.

1.3 General Objectives

To assess the influence of project risk management practices on quality performance in water reticulation projects implemented by Southern Water and Sanitation Company (SWSC) in Choma District.

1.3.1 Specific Objectives

1. To assess the project risk management practices employed by SWSC in the implementation of water reticulation projects in Choma District.
2. To evaluate the quality performance of water reticulation projects undertaken by SWSC in Choma District.
3. To determine the influence of project risk management practices on the quality performance of water reticulation projects undertaken by SWSC in Choma District.

1.4 Conceptual Framework

The framework considered project risk management practices as the independent variable, measured through risk identification, risk assessment, risk response, and risk monitoring and control, while quality performance is the dependent variable, measured through compliance with technical specifications, reliability and functionality of water networks, quality of materials and workmanship, frequency of defects and rework, compliance with project schedules and construction standards, and user or community satisfaction. The framework assumed that effective identification and assessment of project risks enable SWSC to recognise and prioritise potential threats, while

appropriate risk response strategies help reduce their effects on project implementation. Continuous risk monitoring and control further enables the organisation to identify emerging risks and take corrective measures during project implementation. Therefore, the framework proposed that effective project risk management practices can contribute to improved quality performance by reducing defects and rework, improving compliance with technical requirements and standards, supporting reliable and functional water infrastructure, and improving adherence to project schedules. The study assessed the project risk management practices employed by SWSC, evaluate the quality performance of water reticulation projects, and finally determine the influence of project risk management practices on quality performance.

2. Literature Review

2.1 Project Risk Management Practices in Water Reticulation Projects

Risk identification is the first major stage of project risk management and involves the systematic process of recognising events, conditions, uncertainties, and circumstances that may negatively affect the successful implementation of a water reticulation project (Ma, 2021). It requires project managers, engineers, contractors, consultants, and other stakeholders to consider what could go wrong at different stages of the project and how such events could affect project objectives. Early identification is important because risks that are recognised before they occur can be assessed and addressed through planned management measures. In contrast, risks that are not identified may only become visible after they have already caused delays, cost increases, rework, defects, or disputes (Koulinas, 2021).

Water reticulation projects are exposed to a range of technical, financial, procurement, environmental, organisational, and social risks (Rodríguez, 2021). Technical risks may include inaccurate site surveys, inappropriate designs, inadequate specifications, unsuitable pipe materials, poor construction methods, and unexpected ground conditions (Roozbahani, 2024).

Technical assessments and feasibility studies can provide additional information about soil conditions, topography, water sources, existing networks, and the technical requirements of the proposed system. These activities help project teams develop a clearer understanding of the risks that may arise during implementation (Maffettone, 2022).

2.2 Quality Performance of Water Reticulation Projects

Water reticulation projects involve several interconnected components, including pipelines, valves, fittings, water meters, storage facilities, pumping systems, connection points, and related infrastructure. The performance of each component can influence the performance of the overall network. A failure in one part of the system may affect other sections and reduce the reliability of water supply. Water infrastructure performance is therefore dependent on the interaction between technical components, management practices, available resources, and operating conditions (Nyika, 2023). Effective risk assessment across the project life cycle can assist in identifying factors that may affect the performance of interconnected water infrastructure components (Ma, 2021).

Compliance with technical specifications is an important indicator of quality performance in water reticulation projects because it determines whether the completed infrastructure has been constructed according to the approved engineering design, contractual requirements, applicable standards, and specified performance requirements (Aiyetan, 2021). Technical specifications provide detailed requirements relating to the type and quality of materials, pipe dimensions, pressure ratings, installation methods, excavation depths, pipe bedding, jointing, backfilling, testing, and commissioning. Compliance with these requirements helps ensure that the completed water reticulation system is safe, functional, durable, and capable of providing the intended water service (Abaza, 2024).

Material compliance is another important consideration. Pipes, valves, meters, fittings, pumps, and other components should meet the specifications established in project documents. Materials should be inspected when delivered to the construction site to confirm that they correspond with approved requirements. Certification and other documentation can also provide evidence of conformity. Where materials do not meet specifications, their use may increase the probability of defects and premature failure. Material quality and appropriate technical controls are therefore important elements of infrastructure risk management (Dehghani, 2022).

Testing provides another mechanism for assessing compliance. Pressure testing, inspection of joints, verification of pipe alignment, and other technical tests can determine whether the completed infrastructure meets specified requirements. Testing is particularly important because some defects may not be visible during normal inspection. A pipeline may appear properly installed but develop leakage when subjected to operating pressure. Testing provides evidence that the infrastructure can perform under expected conditions. Where defects are detected, corrective action can be undertaken before commissioning (Dehghani, 2022).

2.3 Influence of Project Risk Management Practices on Quality Performance of Water Reticulation Projects

The influence of project risk management practices on the quality performance of water reticulation projects is based on the relationship between how project risks are managed and the extent to which completed water infrastructure meets required technical, functional, safety, durability, and service delivery standards (Aiyetan, 2021). Water reticulation projects involve several sources of uncertainty, including technical conditions, procurement, finance, contractor performance, environmental conditions, stakeholder expectations, and changes in project requirements (Rasul, 2021). If these risks are not properly managed, they can result in defects, rework, delays, cost increases, leakage, inadequate water pressure, premature infrastructure failure, and unreliable water services (Aiyetan, 2021). Effective project risk management can therefore contribute to improved quality by identifying potential problems early and introducing measures to prevent or minimise their effects (Rahi, 2021).

Risk identification is the first stage of the project risk management process and provides the basis for recognising events, conditions, and circumstances that may affect the successful implementation and quality performance of water reticulation projects (Rasul, 2021). It involves

systematically identifying potential risks before and during project implementation so that appropriate measures can be developed to prevent or reduce their effects. In water reticulation projects, risks may arise from technical, financial, procurement, environmental, contractual, operational, stakeholder, and construction-related conditions (Gondaliya, 2025). Effective risk identification allows project teams to understand these potential threats before they develop into defects, delays, cost overruns, or failures of the completed water network (Rahi, 2021).

Risk identification can be undertaken through site inspections, feasibility studies, technical assessments, engineering surveys, consultations with contractors and communities, review of previous projects, examination of project documents, and discussions with relevant stakeholders (Gondaliya, 2025; Aiyetan, 2021). Site inspections can reveal physical conditions that may affect construction, such as unstable soils, existing underground infrastructure, difficult terrain, drainage problems, or restricted access. Identifying such conditions before construction allows engineers and project managers to incorporate appropriate measures into the project design and construction plan (Gondaliya, 2025, 2023).

3. Research Methodology

3.1 Research Design

The study used an exploratory case study design and adopted a mixed methods approach to collect primary data.

3.2 Target Population

The target population for this study consisted of project managers, architects, engineers responsible for the Water Reticulation Projects at SWSC.

3.3 Sample Size

The study consisted of 92 participants.

3.4 Sampling

The study employed a convenience sampling technique, a form of non probability sampling in which participants were selected based on their availability and willingness to take part.

3.5 Data Collection Methods

The primary research tool used in the study was a semi structured questionnaire, which included both closed ended and open ended questions. This design was well suited for mixed methods research, as it allowed for the collection of both quantitative and qualitative data. Primary data were gathered using structured surveys involving standardized questionnaires administered mainly through electronic platforms, with some face to face interviews conducted as needed.

4. Result Presentation

4.1 Presentation of results on background characteristics of the respondents

The findings show that 52 respondents (56.5%) were male, while 40 respondents (43.5%) were female. This indicates that male respondents constituted a slightly larger proportion of the study participants.

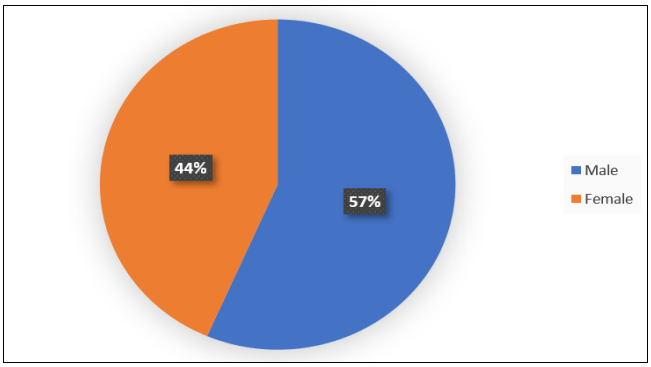


Fig 4.1.1: Gender

The findings indicate that 31 respondents (33.7%) were aged 25 to 34 years, followed by 27 (29.3%) aged 35 to 44 years. Respondents below 25 years accounted for 12 (13.0%), while 15 (16.3%) were aged 45 to 54 years and 7 (7.6%) were 55 years and above. This shows that most respondents were within the 25 to 44-year age range.

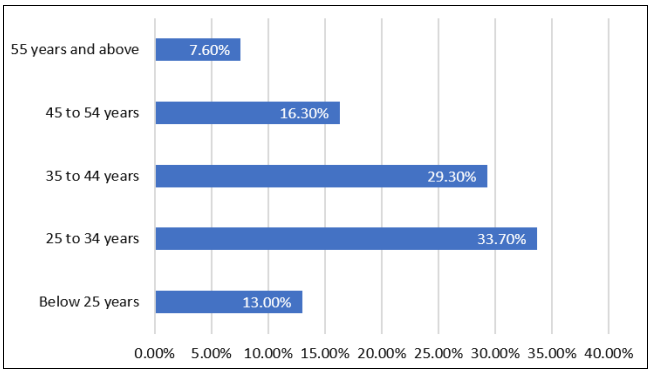


Fig 4.1.2: Age Group

The findings show that 31 respondents (33.7%) had Bachelor's Degrees, while 27 (29.3%) had Diplomas. Certificate holders accounted for 18 (19.6%), Master's Degree holders for 12 (13.0%), and Doctorate holders for 4 (4.3%).

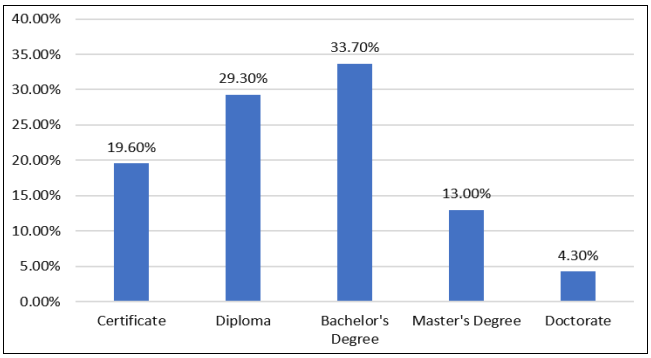


Fig 4.1.3: Highest Level of Education

The findings indicate that 24 respondents (26.1%) were Supervisors, followed by 22 (23.9%) Technicians and 19 (20.7%) Engineers. Project Managers and Quality Assurance Officers each accounted for 8 (8.7%), while Risk Management Officers represented 5 (5.4%). Other positions accounted for 6 (6.5%).

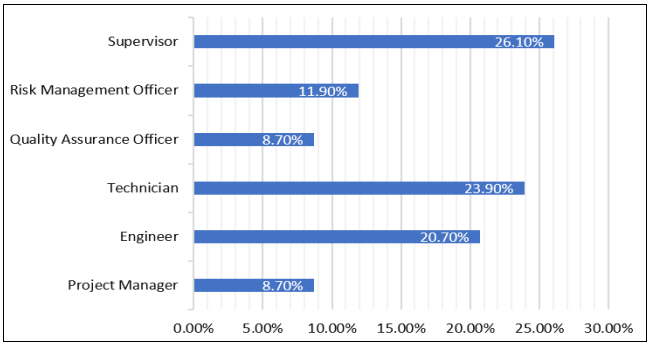


Fig 4.1.4: Current Position at SWSC

The findings show that 29 respondents (31.5%) were from Engineering/Projects, making it the largest departmental group. Operations accounted for 18 (19.6%), Procurement for 17 (18.5%), Quality Assurance for 10 (10.9%), Risk Management for 7 (7.6%), and other departments for 11 (12.0%).

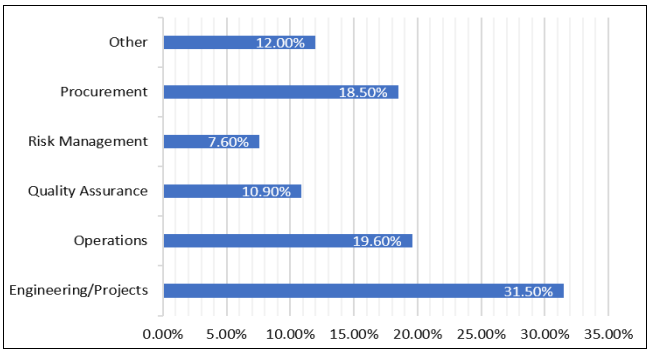


Fig 4.1.5: Department

The findings indicate that 29 respondents (31.5%) had 6 to 10 years of experience, followed by 24 (26.1%) with 2 to 5 years. Those with 11 to 15 years accounted for 18 (19.6%), while 11 (12.0%) had more than 15 years and 10 (10.9%) had less than 2 years.

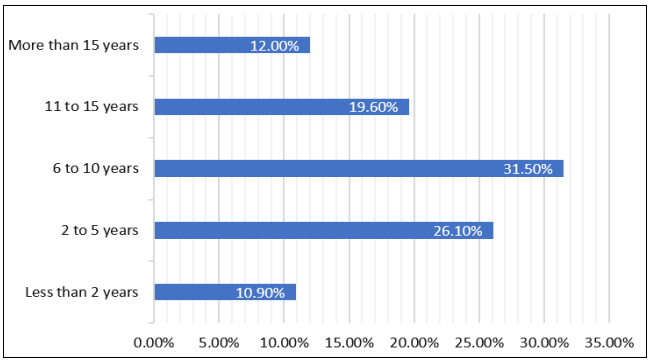


Fig 4.1.6: Years of Experience

4.2 Project Risk Management Practices

The findings show that 29 respondents (31.5%) identified risk monitoring as the most frequently conducted activity, followed by risk identification at 24 (26.1%). Risk response planning accounted for 21 (22.8%), while risk assessment accounted for 18 (19.6%).

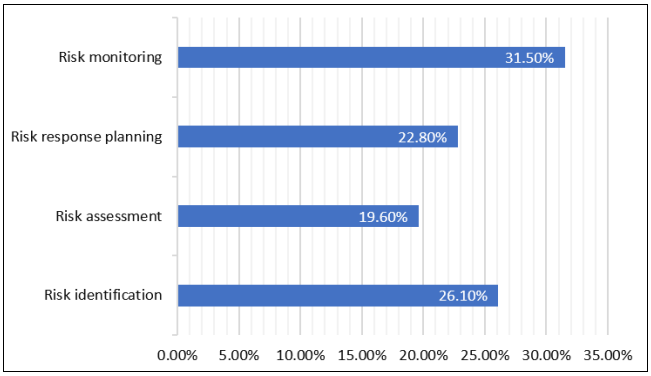


Fig 4.2.1: Most Frequently Conducted Risk Management Activity

The findings indicate that 36 respondents (39.1%) identified project planning as the stage where risks are most commonly identified, while 35 (38.0%) identified project implementation. Project design accounted for 17 (18.5%), and project closure for 4 (4.3%).

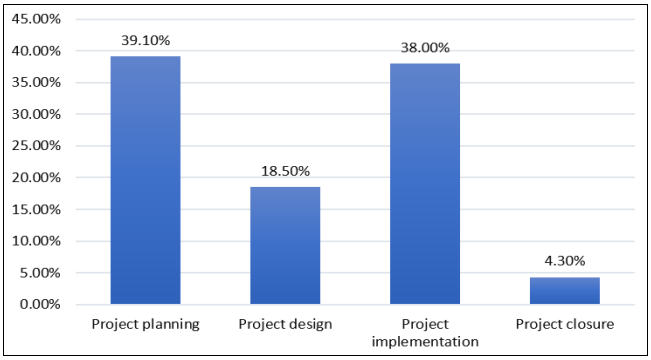


Fig 4.2.2: Stage at Which Risks Are Identified

The findings show that 29 respondents (31.5%) identified site inspections as the main method used to identify risks, followed by team meetings at 24 (26.1%). Risk registers accounted for 22 (23.9%), while expert consultation accounted for 17 (18.5%).

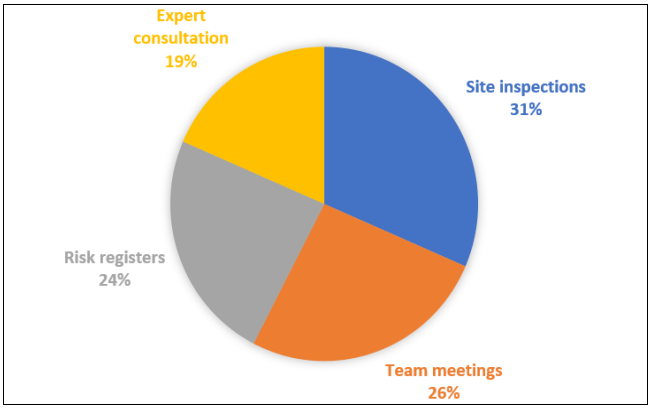


Fig 4.2.3: Main Risk Identification Method

The findings indicate that 31 respondents (33.7%) identified technical risks as the most frequent category, followed by operational risks at 26 (28.3%) and financial risks at 22 (23.9%). Environmental risks accounted for 13 (14.1%).

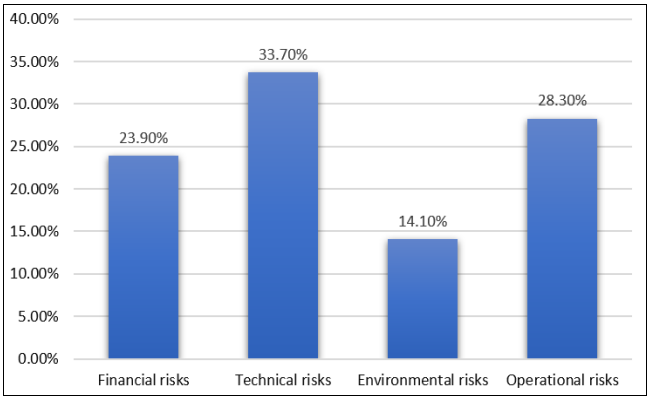


Fig 4.2.4: Most Frequent Risk Category

The findings show that 37 respondents (40.2%) stated that all project team members were primarily responsible for managing risks. The Risk Management Team accounted for 21 (22.8%), Site Engineers for 18 (19.6%), and Project Managers for 16 (17.4%). This indicates that risk management was viewed as a shared responsibility.

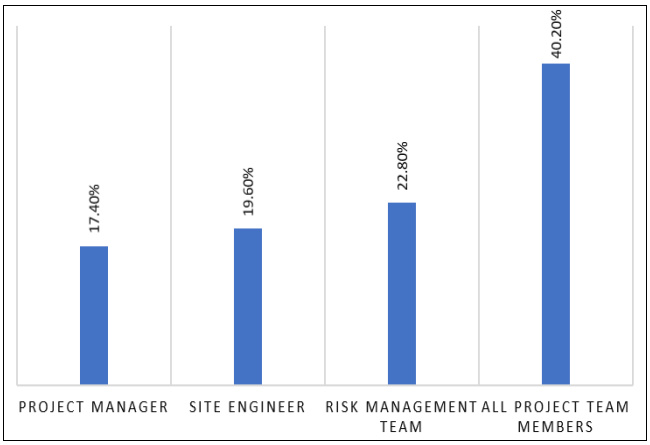


Fig 4.2.5: Primary Responsibility for Risk Management

The findings indicate that 51 respondents (55.4%) identified the risk register as the most commonly used document for recording project risks. Progress reports accounted for 15 (16.3%), inspection reports for 14 (15.2%), and incident reports for 12 (13.0%).

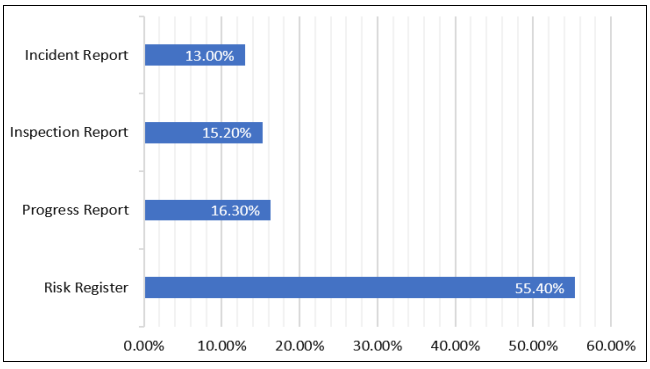


Fig 4.2.6: Document Used to Record Risks

The findings show that 52 respondents (56.5%) identified risk mitigation as the most frequently used strategy. Risk transfer and risk acceptance each accounted for 14 (15.2%), while risk avoidance accounted for 12 (13.0%).

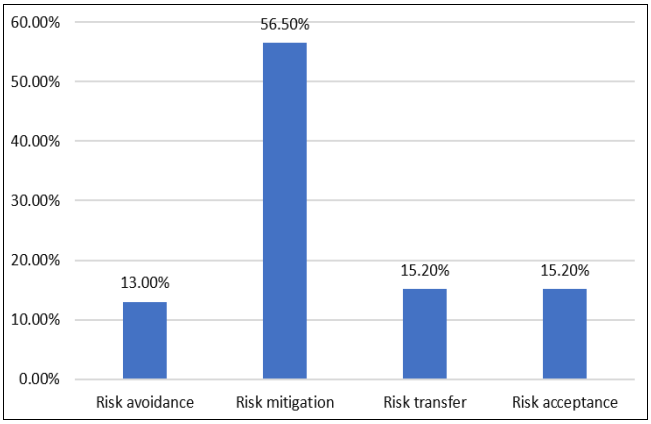


Fig 4.2.7: Most Frequently Used Risk Management Strategy

4.3 Quality Performance

The findings show that 43 respondents (46.7%) rated the overall quality of completed water reticulation projects as good, while 14 (15.2%) rated it excellent. A total of 27 (29.3%) rated the quality as fair, while 8 (8.7%) rated it poor.

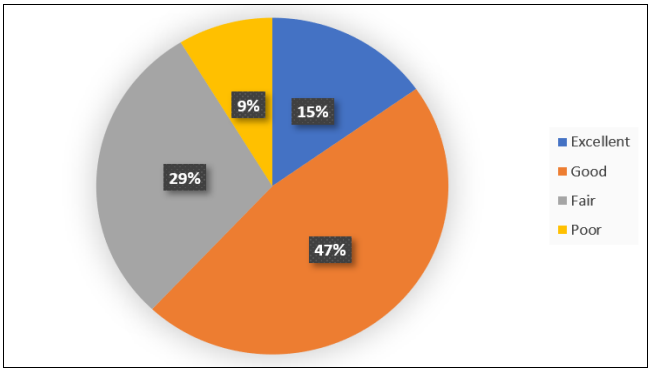


Fig 4.3.1: Overall Quality of Completed Projects

The findings indicate that 29 respondents (31.5%) identified reliable water supply as the most frequently achieved quality indicator, followed by compliance with standards at 27 (29.3%). Low defect rates and long service life each accounted for 18 (19.6%).

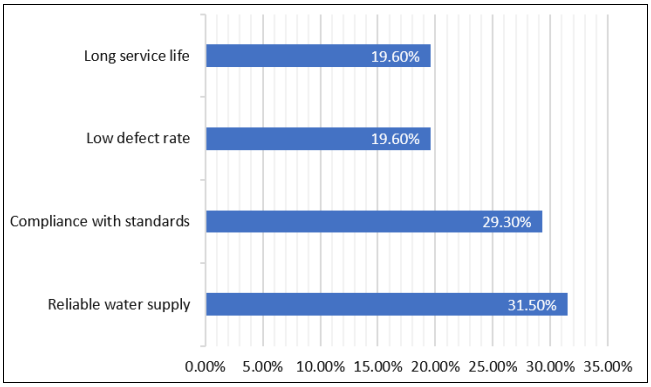


Fig 4.3.2: Most Frequently Achieved Quality Indicator

The findings show that 34 respondents (37.0%) identified poor workmanship as the most common cause of quality defects. Low-quality materials accounted for 25 (27.2%), inadequate supervision for 19 (20.7%), and design errors for 14 (15.2%).

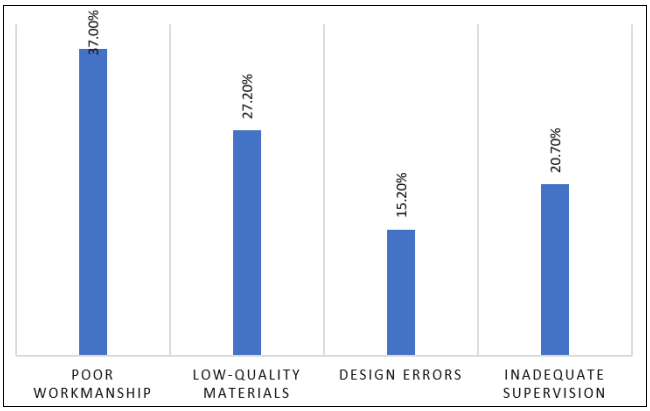


Fig 4.3.3: Common Cause of Quality Defects

The findings indicate that 48 respondents (52.2%) identified site inspections as the most commonly used method for assessing project quality. Pressure testing accounted for 17 (18.5%), material testing for 15 (16.3%), and final quality audits for 12 (13.0%). This demonstrates the importance of site inspections in quality assessment.

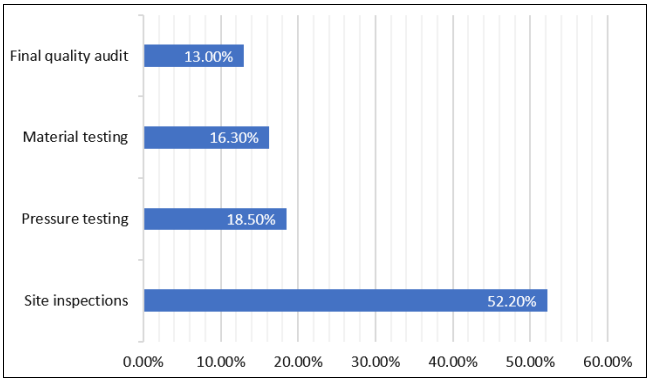


Fig 4.3.4: Common Inspection Method

The findings show that 39 respondents (42.4%) reported that quality inspections were conducted weekly, while 24 (26.1%) reported daily inspections. Monthly inspections accounted for 19 (20.7%), while 10 (10.9%) reported inspections only at project completion.

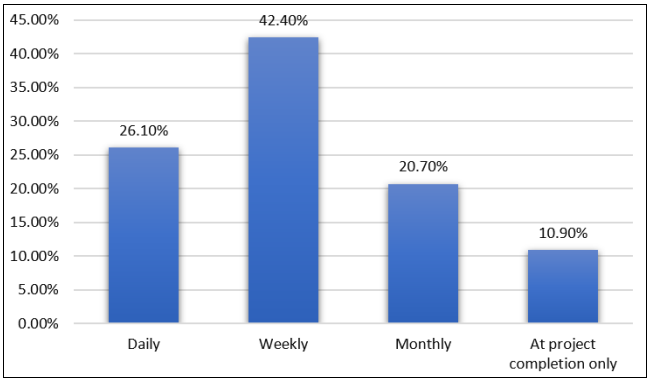


Fig 4.3.5: Frequency of Quality Inspections

The findings indicate that 43 respondents (46.7%) identified pipelines as the project component experiencing the highest number of quality defects. Valves accounted for 17 (18.5%), while reservoirs and pump stations each accounted for 16 (17.4%). This suggests that pipelines were the main component associated with quality defects.

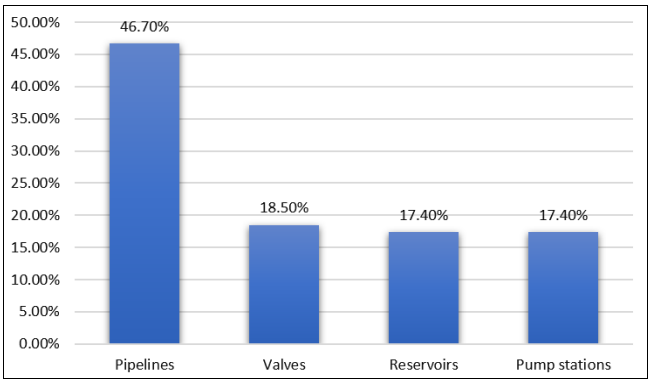


Fig 4.3.6: Component with Most Quality Defects

4.4 Influence of Risk Management on Quality Performance

The findings indicate that 31 respondents (33.7%) identified risk response planning as the project risk management practice with the greatest influence on quality. Risk monitoring accounted for 23 (25.0%), risk identification for 20 (21.7%), and risk assessment for 18 (19.6%).

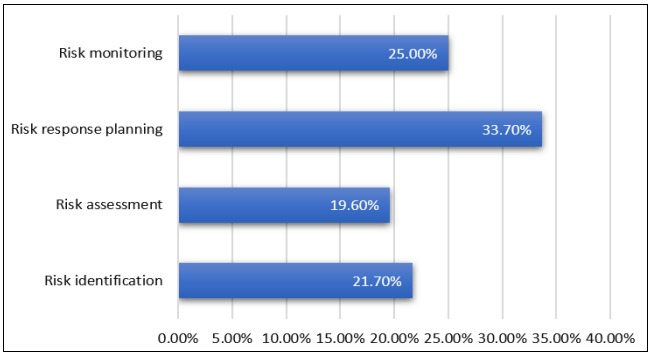


Fig 4.4.1: Risk Management Practice with Greatest Influence

The findings show that 41 respondents (44.6%) identified construction quality as the outcome most affected by ineffective risk management. Project completion time accounted for 22 (23.9%), project cost for 17 (18.5%), and worker safety for 12 (13.0%).

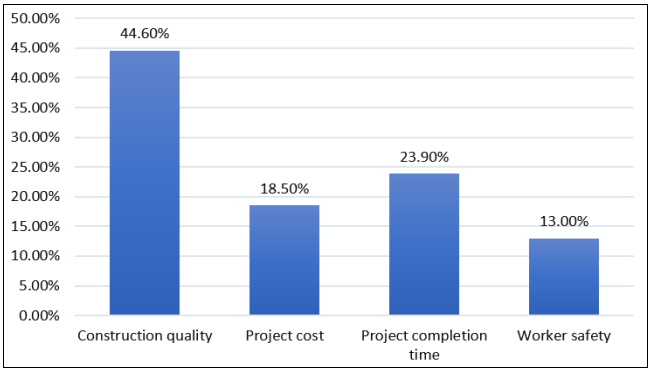


Fig 4.4.2: Outcome Most Affected by Ineffective Risk Management

The findings indicate that 32 respondents (34.8%) identified fewer defects as the quality outcome most commonly achieved when project risks are effectively managed. Better compliance with standards accounted for 27 (29.3%), improved durability for 19 (20.7%), and higher customer satisfaction for 14 (15.2%).

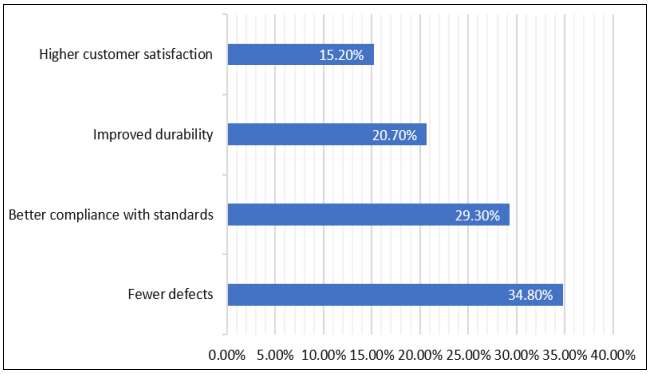


Fig 4.4.3: Quality Outcome Achieved Through Effective Risk Management

The findings show that 39 respondents (42.4%) identified technical risks as having the greatest impact on quality performance. Procurement risks accounted for 25 (27.2%), financial risks for 16 (17.4%), and environmental risks for 12 (13.0%). This indicates that technical risks were perceived as the main risk category affecting project quality.

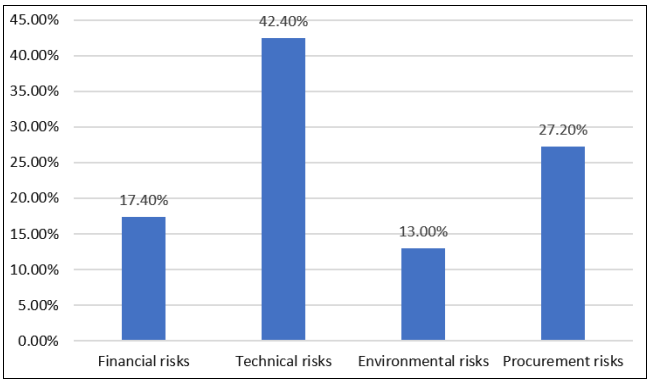


Fig 4.4.4: Risk Type with Greatest Impact on Quality

The findings indicate that 39 respondents (42.4%) identified construction as the project phase that benefits most from effective risk management, followed by planning at 31 (33.7%). Design accounted for 16 (17.4%), while project closure accounted for 6 (6.5%).

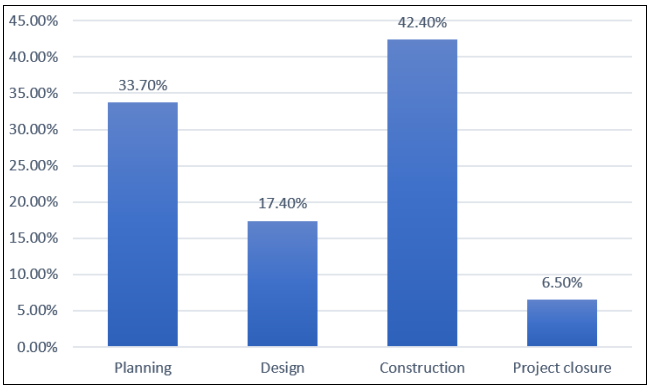


Fig 4.4.5: Project Phase Benefiting Most from Risk Management

The findings show that 34 respondents (37.0%) associated regular risk monitoring with reduced defects. Improved workmanship accounted for 23 (25.0%), better material quality for 20 (21.7%), and faster project completion for 15 (16.3%).

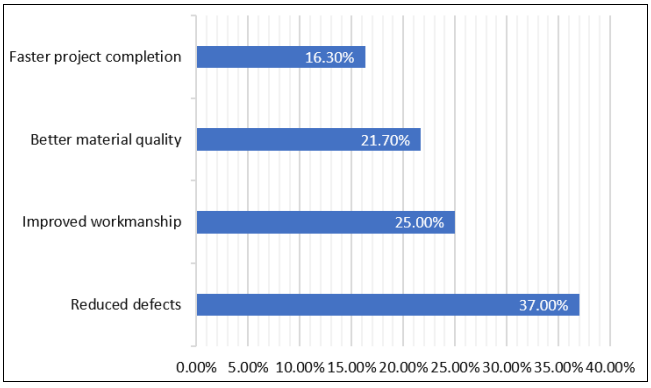


Fig 4.4.6: Quality Improvement Associated with Risk Monitoring

The findings indicate that 36 respondents (39.1%) identified skilled personnel as the project resource contributing most to effective risk management and quality performance. Quality materials accounted for 26 (28.3%), adequate funding for 17 (18.5%), and modern equipment for 13 (14.1%).

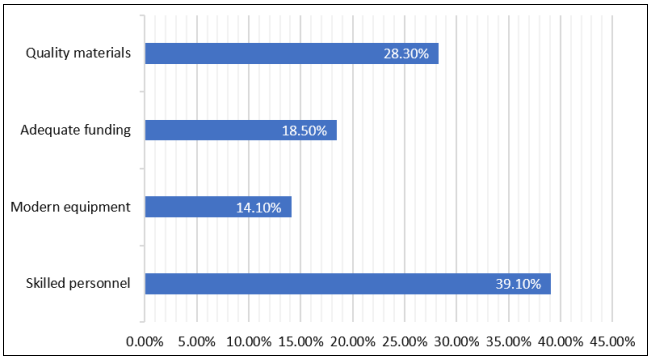


Fig 4.4.7: Resource Contributing Most to Risk Management and Quality

The findings show that 29 respondents (31.5%) identified regular inspections as the project management practice that best supports both risk management and quality improvement. Effective communication accounted for 26 (28.3%), detailed planning for 20 (21.7%), and staff training for 17 (18.5%).

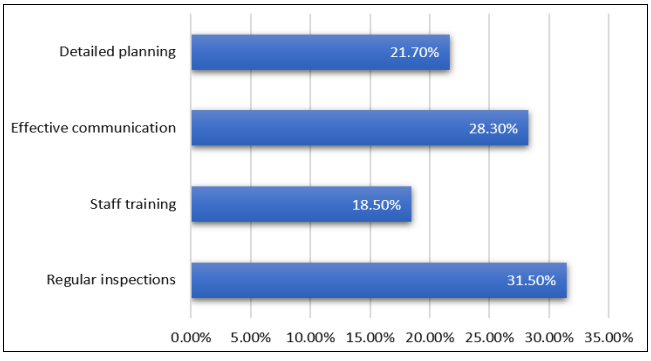


Fig 4.4.8: Practice Supporting Risk Management and Quality

Based on the descriptive findings, overall quality performance provided a suitable binary outcome for logistic regression analysis. Of the 92 respondents, 57 (61.9%) rated the quality of completed water reticulation projects as good or excellent, while 35 (38.0%) rated it as fair or poor. Risk

response planning was selected by 31 respondents (33.7%) as the risk management practice most strongly associated with quality performance, followed by risk monitoring at 23 (25.0%), risk identification at 20 (21.7%), and risk assessment at 18 (19.6%).

The logistic regression results indicate that risk response planning had the strongest association with good or excellent quality performance. Compared with risk assessment, respondents reporting risk response planning had 6.857 times higher odds of reporting good or excellent quality performance (OR = 6.857, 95% CI: 1.884–24.960, p = 0.003). Risk monitoring was also significantly associated with quality performance, with respondents reporting this practice having 4.571 times higher odds of reporting good or excellent quality compared with the reference category (OR = 4.571, 95% CI: 1.218–17.158, p = 0.024). Risk identification showed a positive but statistically insignificant association with good or excellent quality performance (OR = 2.444, 95% CI: 0.654–9.130, p = 0.184). Overall, the findings indicate that risk response planning and risk monitoring were the practices most strongly associated with higher reported quality performance, with risk response planning showing the largest observed association. These results should be interpreted as associations and do not establish that the identified risk management practices directly caused improvements in quality performance.

Table 4.4.1: Logistic Regression Analysis of Factors Associated with Good/Excellent Quality Performance

Predictor	Category/ Frequency	B	S.E.	Wald	p-value	Exp (B)	95% C.I. for Exp(B)
Risk response planning	31 (33.7%)	1.925	0.659	8.531	0.003	6.857	1.884–24.960
Risk monitoring	23 (25.0%)	1.520	0.675	5.073	0.024	4.571	1.218–17.158
Risk identification	20 (21.7%)	0.894	0.672	1.767	0.184	2.444	0.654–9.130
Constant	—	-0.693	0.500	1.922	0.166	0.500	—

Dependent variable: Overall quality performance
(1 = Good/Excellent; 0 = Fair/Poor)

5. Discussion

The study established that Southern Water and Sanitation Company (SWSC) employed several project risk management practices in implementing water reticulation projects in Choma District, including risk identification, assessment, response planning, and monitoring. Risk monitoring (31.5%) and mitigation (56.5%) were the most frequently reported practices and response strategies, respectively. However, limited financial resources (26.1%), procurement and material delays (21.7%), inadequate risk management skills (19.6%), and poor communication (17.4%) constrained their effectiveness. These findings agree with Tukamuhabwa *et al*. (2023) [27], who identified a significant relationship between risk management practices and the performance of water and sanitation projects in southwestern Uganda. Similarly, Rotich and Wanyoike (2025) reported a positive relationship between risk management and the implementation of water and sanitation projects in Kenya.

The study found that the quality performance of SWSC water reticulation projects was generally positive, with 61.9% of respondents rating quality as good or excellent. However, 38.0% rated quality as fair or poor. Poor workmanship (37.0%) was the leading cause of defects, followed by low-quality materials (27.2%), inadequate supervision (20.7%), and design errors (15.2%). Pipelines were the components most affected by defects (46.7%). These findings are consistent with McDermot *et al*. (2022) [13], who highlighted inadequate planning, insufficient ground investigation, unrealistic estimates, and weaknesses in project delivery systems as contributors to infrastructure project problems. Abaza and Kisi (2024) [1] also identified technical deficiencies and project management challenges in water infrastructure projects. These studies support the need to strengthen construction supervision, material testing, procurement controls, and compliance with technical standards.

The study further established that risk response planning (33.7%) and monitoring (25.0%) were perceived as the practices with the greatest influence on quality performance. Technical risks (42.4%) and procurement risks (27.2%) were identified as the main risk categories affecting quality. These findings are consistent with Ireri and Mungai (2025) [9], who found significant relationships between risk identification, risk response planning, and the performance of public water projects in Kajiado County, Kenya. Aiyetan and Das (2021) [2] also emphasised the importance of collaboration, communication, accountability, monitoring, and competent personnel in infrastructure delivery. Overall, the findings indicate that risk management can contribute to fewer defects, improved compliance with standards, and greater durability. However, SWSC needs to integrate risk management with quality assurance, staff training, adequate funding, procurement management, and technical supervision to improve the quality of water reticulation projects in Choma District.

6. Conclusion

The study concludes that Southern Water and Sanitation Company (SWSC) employed several project risk management practices in the implementation of water reticulation projects in Choma District. In relation to the first objective, the findings established that risk identification, risk assessment, risk response planning, and risk monitoring and control were used, with risk monitoring and risk mitigation being the most prominent practices. Risk identification was mainly undertaken during project planning and implementation, while site inspections and risk registers were important mechanisms for identifying and documenting risks. However, the effectiveness of these practices was constrained by limited financial resources, procurement and material delays, inadequate risk management skills, poor communication and coordination, and changing project conditions. The study therefore concludes that SWSC had a risk management framework in place, but its effectiveness depended on adequate resources, technical capacity, coordination, and continuous monitoring.

In relation to the second objective, the study concludes that the quality performance of SWSC water reticulation projects in Choma District was generally satisfactory, although quality weaknesses remained. Most respondents rated the quality of completed projects as good or excellent, while

reliable water supply and compliance with technical standards were the most commonly reported quality indicators. However, poor workmanship, low-quality materials, inadequate supervision, design problems, and procurement and supply delays continued to contribute to quality defects. Pipeline works were also identified as the project component most affected by quality problems. The study therefore concludes that although SWSC achieved acceptable quality outcomes in many projects, sustained quality performance requires stronger construction supervision, material testing, staff training, procurement controls, and adherence to technical standards.

In relation to the third objective, the study concludes that project risk management practices influenced the quality performance of water reticulation projects undertaken by SWSC. Risk response planning and risk monitoring were perceived to have the greatest influence on quality, while technical and procurement risks were the main risk categories affecting quality performance. Effective risk management was associated with fewer defects, better compliance with standards, improved durability, and better construction outcomes. However, the findings also show that risk management alone was not sufficient to guarantee quality because workmanship, material quality, supervision, skills, financial resources, and procurement conditions also affected project outcomes.

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