Int. j. adv. multidisc. res. stud. 2026; 6(1):639-649

Received: 25-11-2025
Accepted: 05-01-2026

International Journal of Advanced Multidisciplinary Research and Studies

ISSN: 2583-049X

Evaluating the Effectiveness of Risk Management Strategies in Project Management: A Case Study of the Lusaka Ndola Road

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Abstract
In large-scale infrastructure projects, risks such as cost overruns, delays, safety concerns, and environmental impacts are common and can compromise project success if not managed effectively. The Lusaka–Ndola Road project, being one of Zambia's most significant infrastructure developments, provides a relevant context for evaluating how risk management strategies are applied and whether they contribute to project performance and sustainability. Effective risk management not only reduces uncertainties but also enhances decision-making, resource allocation, and stakeholder confidence. However, challenges such as inadequate planning, limited financial resources, and weak institutional frameworks often limit the effectiveness of these strategies in developing countries. Against this background, the study assessed the effectiveness of risk management strategies employed in the Lusaka–Ndola Road construction project. Specifically, the study sought to analyze the types of risks involved in road construction projects, establish the risk mitigation strategies applied, examine the effectiveness of risk management techniques, and identify the challenges encountered in implementing risk management during the project. The study used a cross-sectional case study design with a mixed-methods approach, targeting procurement officers, project managers, engineers, and architects at China Railway Seventh Group. A sample of 100 participants was selected through convenience sampling, and data was collected using a semi-structured questionnaire containing both closed- and open-ended questions. STATA was used for data entry and statistical analysis, while Microsoft Excel 365 was utilized to present descriptive statistics through graphical illustrations. For inferential analysis, the Chi-square test was applied to determine the relationships between categorical variables. The results show that technical (42%) and safety risks (34%) were the most common in road construction, followed by environmental (13%) and financial risks (6%). Financial risks were reported to impact projects frequently (38%) or always (35%), while environmental challenges were dominated by water contamination (43%) and weather conditions (37%). Equipment failure was rated as significant (46%) or severe (37%), and safety risks were largely linked to poor site conditions (44%) and inadequate training (39%). Legal and regulatory risks were said to often (39%) or always (41%) delay projects, while labor-related risks were dominated by work-related injuries (41%) and shortages of skilled workers (38%). Mitigation strategies highlighted stakeholder collaboration (45%), contingency planning (20%), and regulatory compliance (25%), with financial planning seen as highly effective by 55% of respondents. Regular safety training was common (monthly 45%, quarterly 35%), and compliance with environmental laws (40%) was viewed as the best way to address environmental risks. Overall, 75% rated risk management techniques as excellent, 55% said they effectively prevent cost overruns, and 85% agreed they improve delivery timelines, though challenges such as insufficient funding (28%), complexity of frameworks (28%), and resistance to change (30%) remained critical barriers. Based on the findings, the study recommends that construction firms prioritize strengthening risk management frameworks through comprehensive training and capacity-building programs to enhance workforce competency and stakeholder collaboration. Financial planning and contingency measures should be systematically integrated into project cycles to mitigate cost overruns and address financial risks effectively.

Keywords: Risk Management Strategies, Project Management, Lusaka Ndola Road

1. Introduction

1.1 Background

Project management is a multidisciplinary discipline that involves the application of knowledge, skills, tools, and techniques to project activities to meet project requirements (Raza, 2023). A critical component of this process is risk management, which refers to the systematic identification, assessment, and prioritization of risks, followed by coordinated strategies to minimize, monitor, and control the probability or impact of unfortunate events (Meyer, 2022). In infrastructure development projects especially, road construction risk management is essential due to the high levels of uncertainty associated with cost overruns, time delays, environmental impact, political interference, and technical challenges (Canesi, 2023).

Globally, the importance of risk management in project execution has gained momentum over the last few decades, particularly in large-scale infrastructure projects. Internationally recognized standards such as ISO 31000 and PMBOK (Project Management Body of Knowledge) emphasize the integration of risk management into all phases of the project lifecycle (Vargas, 2022). Despite these frameworks, global infrastructure projects often suffer from poor risk planning, resulting in significant delays and cost escalations. For instance, studies have shown that nearly 93% of major construction projects worldwide experience budget overruns and time extensions, largely due to insufficient or ineffective risk mitigation strategies (Alhammadi, 2024). This global challenge underscores the need for continuous evaluation of risk management practices.

In the African region, infrastructure development is a key driver of economic growth and regional integration. However, road projects across Sub-Saharan Africa are frequently plagued by risk-related challenges such as political instability, poor governance, inadequate feasibility studies, funding gaps, and corruption (Matu, 2020). The African Union's Programme for Infrastructure Development in Africa (PIDA) emphasizes the critical need for better project planning and risk assessment in regional infrastructure projects (Raza, 2024).

In Zambia, infrastructure development, particularly in the transport sector, is pivotal for national economic development and trade facilitation (Sichoongwe, 2025). The Lusaka-Ndola road is one of the country's most strategic corridors, linking the capital city with the Copperbelt and the Democratic Republic of Congo (DRC) border (Parks, 2023). Despite its economic significance, the project has faced persistent delays, public criticism, funding issues, and questions regarding cost transparency. The Lusaka-Ndola dual carriageway project has been revised multiple times, with cost estimates fluctuating and timelines repeatedly extended. These challenges reflect deeper systemic issues in project risk planning, stakeholder engagement, and execution (Zajobtz, 2023).

The consequences of ineffective risk management in the Lusaka-Ndola road project include economic losses, delayed national development outcomes, reduced investor confidence, and negative public perception (Bobo, 2021) [12]. These issues highlight the need for an in-depth evaluation of the effectiveness of existing risk management strategies in Zambian project management practice (Sichone, 2020).

1.2 Statement of the Problem

In Zambia, road construction projects are frequently plagued by significant delays and cost overruns (Silwimba, 2019). A study focusing on Lusaka identified key contributors to these delays, including late progress payments, challenges in project financing for contractors, and delays in approving major scope changes. These issues often result in extended project timelines and increased costs (Sichone, 2020). Despite the critical role of risk management in mitigating such challenges, its application within Zambia's construction industry remains limited. Research indicates that the adoption of risk management practices is low to moderate, with a predominant reliance on qualitative methods over quantitative approaches (Hauya, 2021). This limited implementation contributes to project inefficiencies and failures. The persistent occurrence of delays and cost overruns, coupled with the inadequate application of risk management strategies, underscores a significant gap in the current project management practices within Zambia's road construction sector (Bobo, 2021) [12]. Addressing this gap is essential to enhance project outcomes and ensure the timely and cost-effective delivery of infrastructure projects.

1.3 General Objectives

To assess the effectiveness of risk management strategies employed in the Lusaka-Ndola Road construction project.

1.3.1 Specific Objectives

1. To establish types of risks involved in road construction projects.
2. To analyse risk mitigation strategies used in road construction projects.
3. To examine the effectiveness of risk management techniques.
4. To analyse the challenges faced in implementing risk management during road construction.

1.4 Conceptual Framework

In the context of evaluating the effectiveness of risk management strategies in the Lusaka-Ndola Road construction project, a comprehensive conceptual framework is essential. This framework encompasses several critical components:

The initial phase involves systematically identifying potential risks that could impact the project. These risks are categorized into environmental, technical, financial, logistical, and stakeholder-related risks (Shimwambwa, 2019). Environmental risks include adverse weather conditions and natural disasters; technical risks pertain to design flaws and construction challenges; financial risks involve budget overruns and funding shortages; logistical risks cover supply chain disruptions and equipment failures; and stakeholder risks encompass community opposition and regulatory changes. Accurate identification of these risks is crucial for subsequent analysis and mitigation efforts (Nomo, 2021).

Following identification, each risk is evaluated in terms of its likelihood of occurrence and potential impact on the project (Mambwe, 2020). This assessment involves analyzing the probability of each risk event and the severity of its consequences. Prioritizing risks based on this analysis enables project managers to focus on the most critical threats, ensuring that resources are allocated effectively to address the most significant risks. Once risks are assessed, appropriate mitigation strategies are developed and implemented (Taylor, 2019).

2. Literature Review

2.1 Types of risks involved in road construction projects

Umar, R., (2021) illustrates that time overrun is prevalent in TSF construction projects as indicated by 86% of the respondents who indicate time overrun was incurred by their projects. 57.1% of the respondents reported their projects overrun cost by less than 5% of the project budget due to time overrun factor. 25% of those who took part in the survey indicated that their projects overspent by 5% of their project budgets, 12.5% overspent 10% of their TSF project budgets while 3.6% overspent at 15% of their project budget. he most significantly ranked cost influence was revealed to be Claims with a standard deviation of Traditional contracting is the most significantly ranked

procurement system for time overrun mitigation partially (Umar, 2021).

Silwamba, M.K., (2023) address the relationship between construction delivery, lead time management, and results of road projects among Itezhi Tezhi road contractors. Findings show a general moderate attitude towards the relationship. Proper management of lead times was found to result in proper project planning and timely project completion, thus yielding quality work. The application of sophisticated technologies in lead time management and stakeholder communication also positively impacted the quality of work (Silwamba, 2023).

2.2 Risk mitigation strategies used in road construction projects

Road and rail transport infrastructure are vulnerable to natural hazards all over the globe. Koks (2019) reported for the first time the global multi-hazard exposure and risk of road and railway infrastructure. Outcomes suggested that ~27% of total road and railway infrastructure worldwide are subjected to at least one hazard and ~7.5% of total infrastructure is exposed to 1/100-year flooding event. Global Expected Annual Damages (EAD) due to direct damage to road and railway infrastructure range from 3.1 to 22 billion US dollars, of which ~73% are caused by surface and river flooding. Global EAD are small compared with global GDP (~0.02%). However, within some countries EAD are 0.5 to 1% of GDP annually, which is the same order as national transport infrastructure expenditure. Cost-benefit analysis suggests that increasing the height of flood protection would yield beneficial returns on ~60% of roads for a 1/100 year flood event.

2.3 Challenges faced in implementing risk management during road construction

Road construction projects are often complex and involve multiple stages, including planning, design, procurement, and execution. Each stage presents unique risks that need to be assessed, and the complexity increases when dealing with long or intricate roadways (Mohammadi, 2022). Additionally, unforeseen challenges such as suboptimal soil conditions, weather disruptions, and unforeseen environmental factors can complicate risk assessment efforts. This inherent uncertainty makes it difficult to develop comprehensive risk management plans and ensures that risks are managed in a consistent and effective manner (Love, 2020).

One of the primary challenges in road construction risk management is the failure to adequately identify and assess risks (El-sayegh, 2021). This often occurs due to a lack of experience, insufficient data, or an over-reliance on standard risk management practices that may not fully capture the unique risks posed by the specific site or project. For example, risks associated with local conditions (such as soil stability, weather patterns, and environmental factors) may be overlooked if they are not thoroughly investigated in the planning phase. Additionally, stakeholders may fail to identify all possible risks, including social or political risks, especially in areas with complex community relations or ongoing political instability. Without a proper risk identification process, risk management plans may be incomplete or inadequate, leaving the project vulnerable to unforeseen complications (Sanni-Anibire, 2020).

Proper risk management requires resources, including skilled personnel, time, and funding. However, many road construction projects face budget constraints that limit the ability to dedicate resources to thorough risk management. The lack of sufficient resources can hinder the identification, evaluation, and mitigation of risks, making it harder to ensure project success (Hubbard, 2020).

3. Research Methodology

3.1 Research Design

The study adopted an exploratory case study, utilizing a mixed method approach.

3.2 Target Population

The target population for this study consisted of procurement officers, project managers, engineers, and architects at China Railway Seventh Group, a construction company responsible for constructing the Lusaka-Ndola Road.

3.3 Sample Size

The sample size for this study consisted 100 participants.

3.4 Sampling

Convenience sampling approach was used to select the study sample.

3.5 Data Collection Methods

Interviews were primarily conducted face-to-face, with electronic questionnaires also being utilized to collect information on the research variables. The main data collection method for this study was a structured questionnaire containing closed-ended questions.

4. Result Presentation

4.1 Presentation of results on background characteristics of the respondents

The respondents' ages ranged between 20 and 60 years, with an average of 39 years. This shows that most participants are in their mid-adulthood stage.

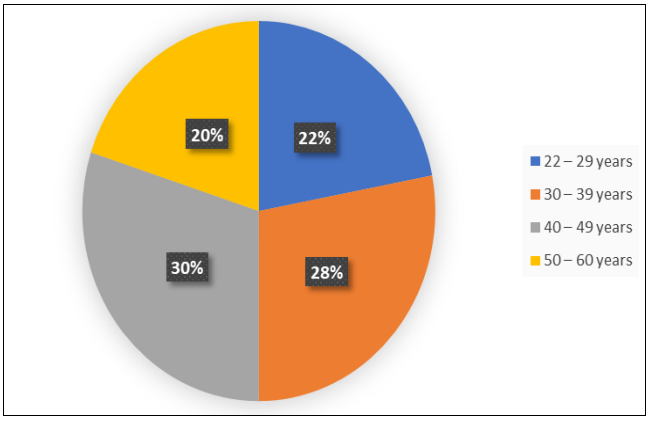

Fig 4.1.1: Age Distribution of Respondents

Participants had work experience ranging from 1 to 30 years, with an average of about 17 years. This indicates a workforce that is fairly experienced.

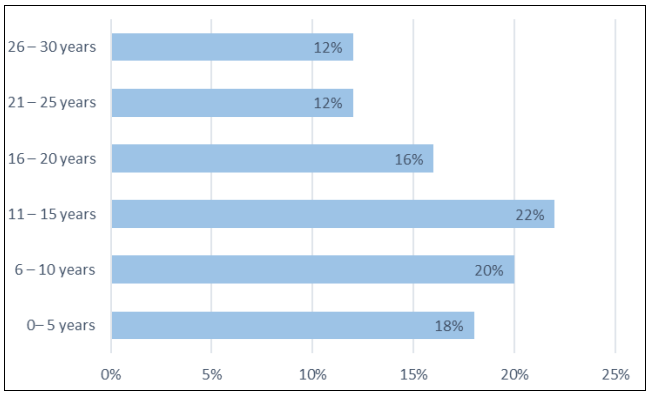

Fig 4.1.2: Work Experience of Participants

The gender distribution is nearly balanced, with 52% female and 48% male participants. This ensures both genders are almost equally represented in the study. The small gap indicates no gender dominance in the sample.

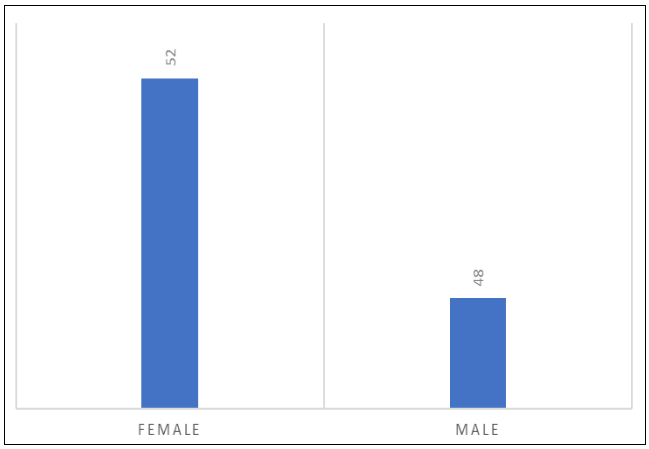

Fig 4.1.3: Gender Composition of the Sample

The sample is highly educated, with many participants holding diplomas, degrees, and postgraduate qualifications. At the same time, 19% reported having only primary/basic education. This mixture shows the study involved respondents across different academic levels.

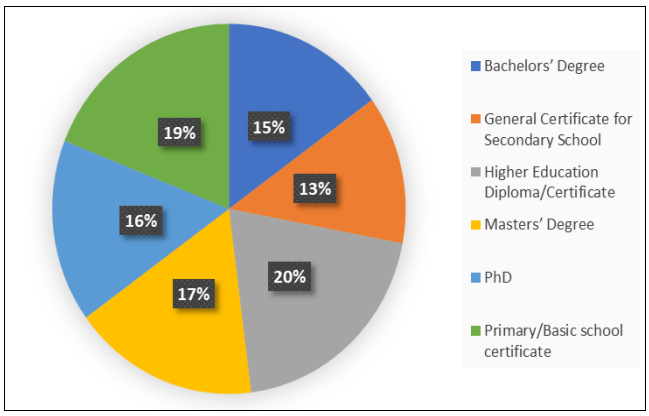

Fig 4.1.4: Educational Levels of Respondents

Project managers form the largest share of respondents at 30%, followed by technicians at 20%. Supervisors were the least represented at only 7%. The diversity of professions reflects a broad range of roles within the sample.

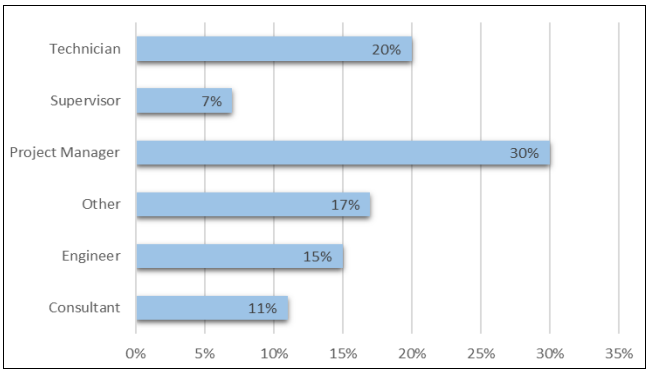

Fig 4.1.5: Professional Roles of Participants

4.2 Types of Risks in Road Construction Projects

The majority of respondents identified technical risks (42%) and safety risks (34%) as the most common in road construction projects. Financial risks were selected by only 6%, while environmental risks stood at 13%. This shows that construction projects are more vulnerable to on-site operational challenges than financial or environmental issues.

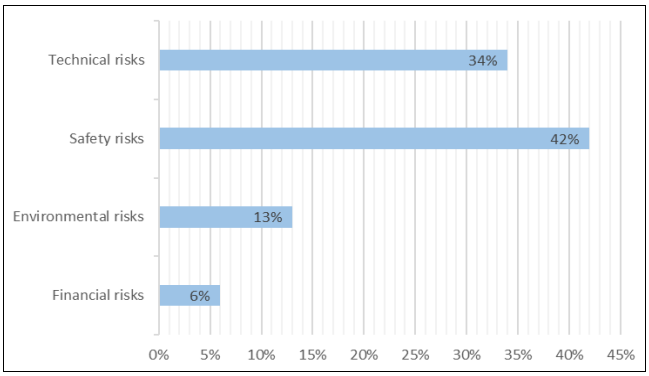

Fig 4.2.1: Common Types of Risks in Road Construction Projects

Most respondents indicated that financial risks affect projects frequently (38%) or always (35%), showing strong financial influence on construction outcomes. Only 5% believed financial risks rarely occur. This suggests financial instability is a persistent challenge in the sector.

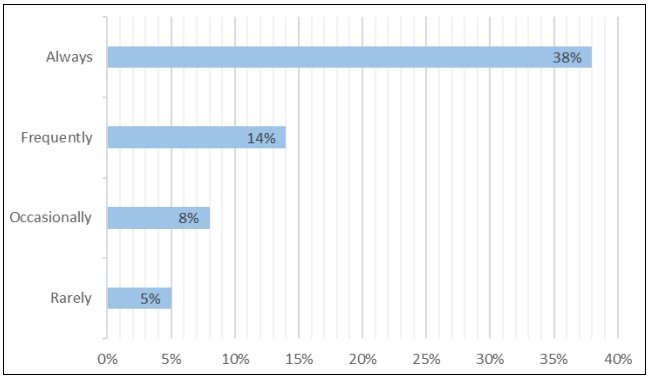

Fig 4.2.2: Frequency of Financial Risk Impact

The leading environmental risks were water contamination (43%) and weather conditions (37%), while land degradation (9%) and noise pollution (6%) were far less cited. This indicates respondents view natural and water-

related challenges as more severe than human-caused disturbances. Environmental considerations are therefore critical to project planning.

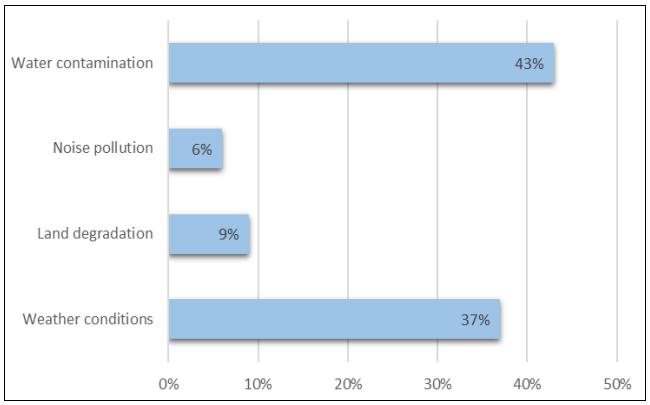

Fig 4.2.3: Most Prevalent Environmental Risks

A majority rated equipment failure as having a significant impact (46%) or a severe impact (37%) on projects. Only 3% thought equipment issues were insignificant, showing how vital machinery reliability is. This confirms that equipment breakdowns directly threaten timelines and budgets.

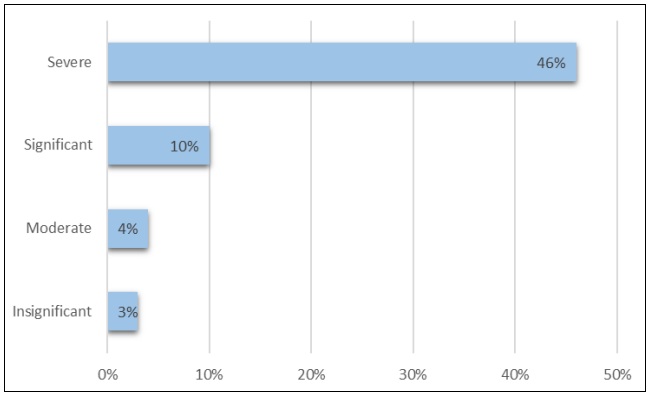

Fig 4.2.4: Effects of Equipment Failure on Projects

Respondents mainly cited poor site conditions (44%) and inadequate worker training (39%) as the key contributors to safety risks. Fewer pointed to lack of PPE (10%) or poor safety regulations (4%). This highlights that safety risks stem more from on-ground practices than policy gaps.

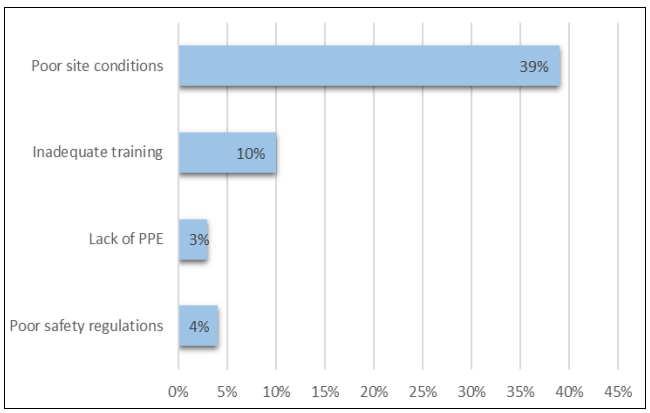

Fig 4.2.5: Key Factors Contributing to Safety Risks

The results show that legal risks often (39%) or always (41%) delay projects, with only 5% reporting no such effects. This demonstrates the strong role of regulation in shaping construction progress. The high percentages reflect delays as a systemic issue.

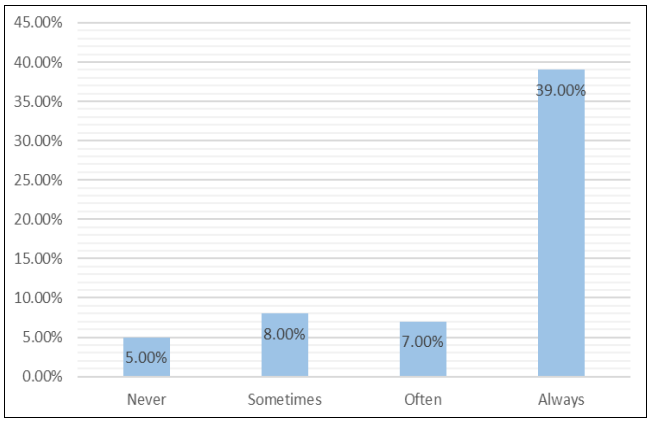

Fig 4.2.6: Effect of Legal and Regulatory Risks on Project Timelines

The majority highlighted work-related injuries (41%) and shortages of skilled workers (38%) as major labor risks. Strikes (3%) and turnover (11%) were less significant. This suggests labor risks are tied more to physical safety and skills gaps than workforce stability.

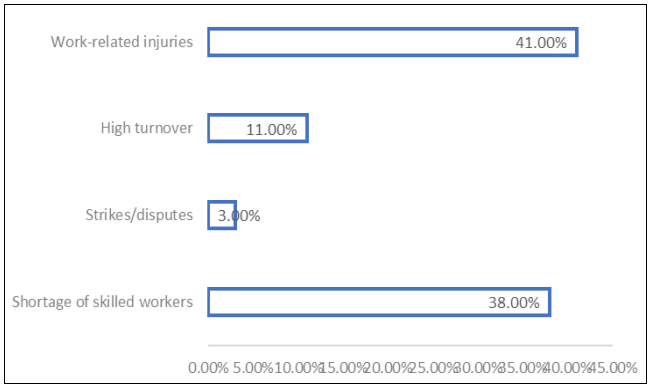

Fig 4.2.7: Most Frequent Labor-Related Risks

The top technical risks were unexpected ground conditions (41%) and poor design specifications (39%). Fewer mentioned feasibility issues (7%) or substandard materials (9%). This reveals site-specific conditions and design flaws are the main technical threats.

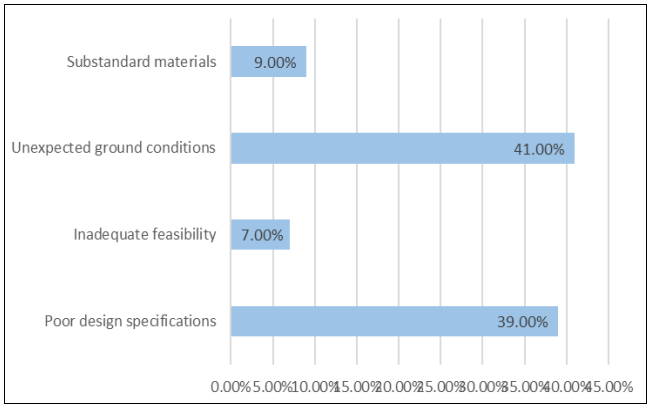

Fig 4.2.8: Primary Technical Risks in Road Construction

Environmental and external risks are highly diverse and interconnected. Weather conditions are the most prevalent external factor, cited in 62% of responses, highlighting its universal challenge. Furthermore, a significant majority of projects (76%) faced combinations of environmental, community, and political issues, demonstrating that external risks are rarely isolated events.

Table 4.2.1: Environmental and External Challenges in Road Construction

	Responses		Percent of Cases
	N	Percent	
Weather conditions	62	17.3%	62%
Community resistance	58	16.2%	58%
Political interference	48	13.4%	48%
Safety risks	38	10.6%	38%
Lack of equipment	37	10.3%	37%
Design flaws	35	9.8%	35%
Total	370	100.0%	370.0%

4.3 Risk Mitigation Strategies in Road Construction Projects

Improved stakeholder collaboration was the most chosen strategy (45%), showing that teamwork and communication are seen as the backbone of risk reduction. Insurance coverage was the least selected (10%), suggesting it's not viewed as a primary line of defense.

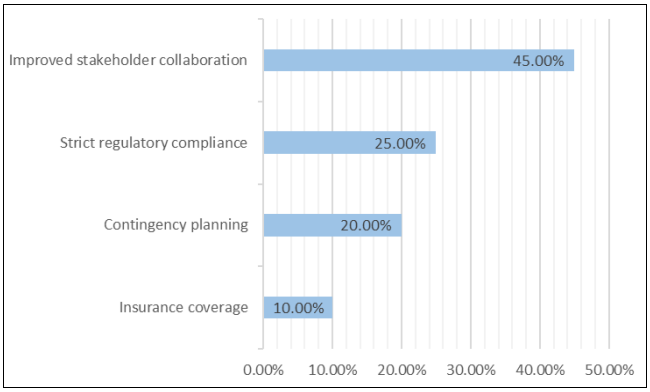

Fig 4.3.1: Most commonly used risk mitigation strategy in road construction

Over half (55%) felt financial planning is highly effective. Together with 30% moderately effective, this shows that budgeting and forecasting are strongly trusted in reducing risks.

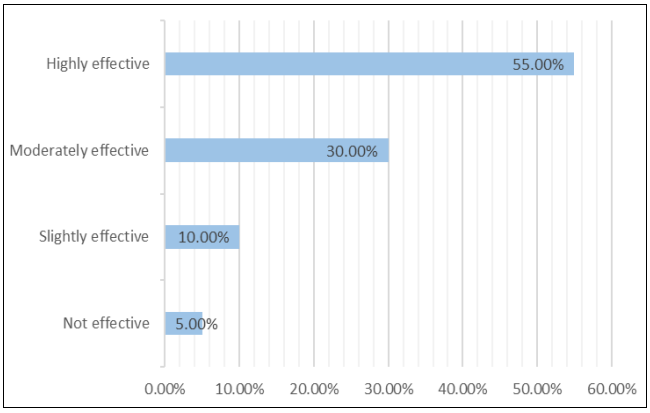

Fig 4.3.2: Effectiveness of financial planning in reducing project risks

Monthly (45%) and quarterly (35%) dominate, showing companies value regular safety drills. Very few projects (5%) reported never holding trainings.

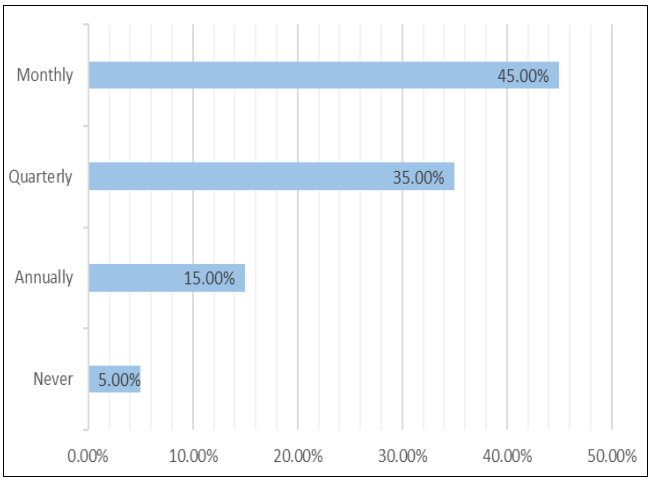

Fig 4.3.3: Frequency of safety training programs for workers

Compliance with environmental laws (40%) and waste management plans (25%) top the list, meaning most firms see legal adherence and practical waste control as key.

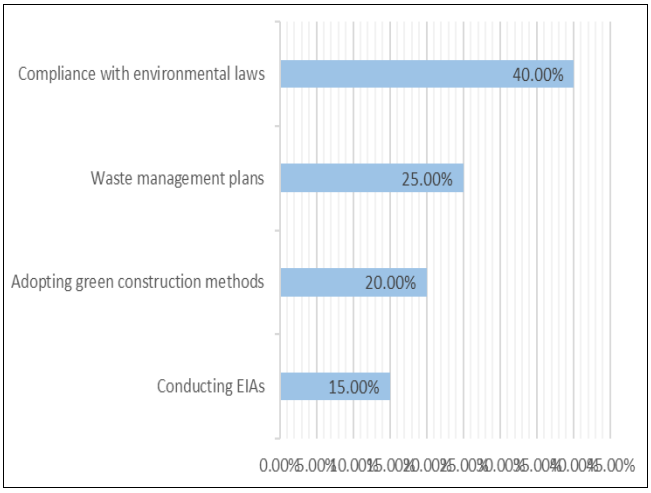

Fig 4.3.4: Most effective way to mitigate environmental risks

A huge majority (60%) rated it as very important, with another 30% calling it important. Barely anyone dismissed its role.

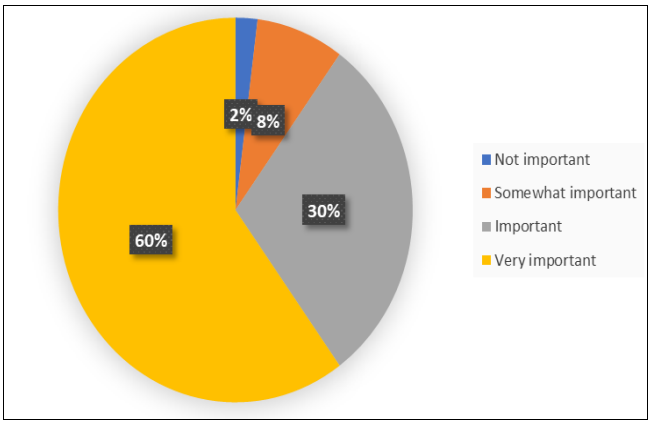

Fig 4.3.5: Importance of stakeholder engagement in managing risks

Quality control measures (35%) and hiring experienced professionals (30%) were top. Feasibility studies (10%) had the least support.

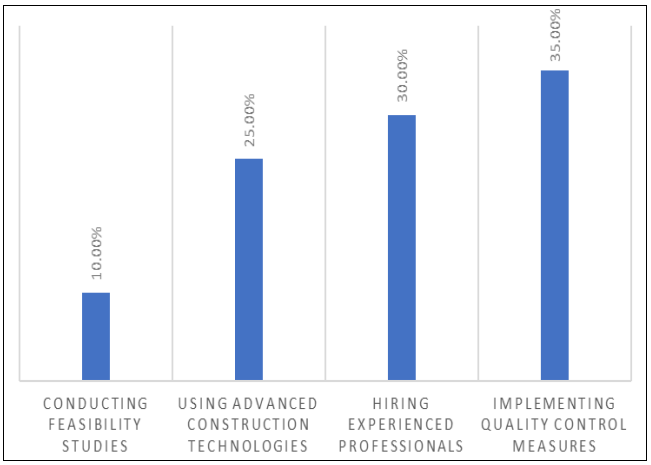

Fig 4.3.6: Effective strategy for handling technical risks

Frequently (40%) and always (40%) dominate, showing that risk checks are embedded in projects. Rarely (5%) was negligible.

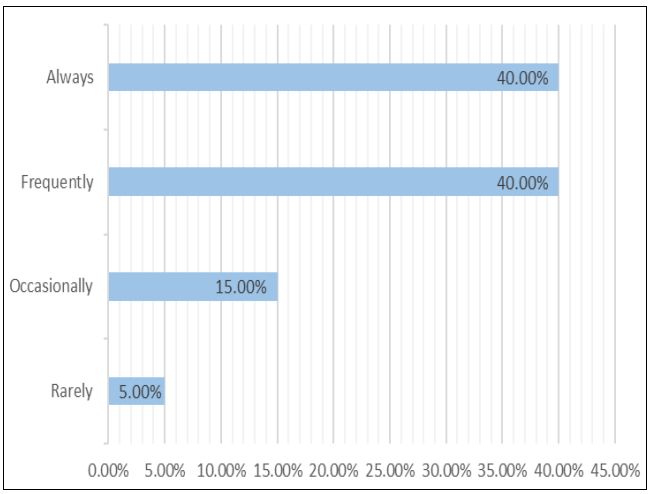

Fig 4.3.7: Frequency of risk assessment exercises

Contractual agreements (40%) and improved working conditions (30%) were most preferred, reflecting the value of security and welfare.

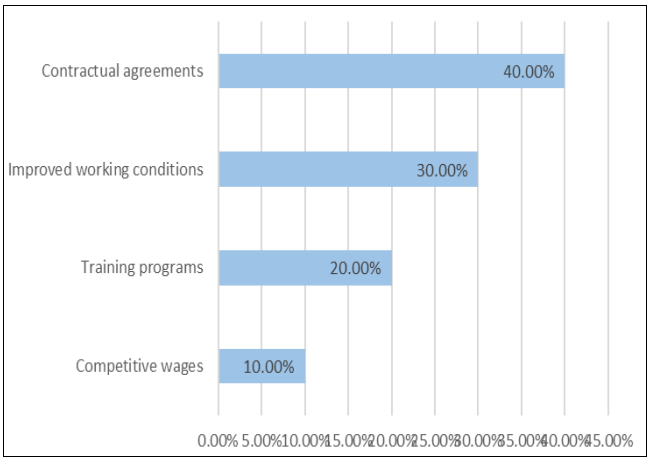

Fig 4.3.8: Common method for mitigating labor-related risks

Meeting legal requirements (35%) and project efficiency (30%) were top reasons. Safety (25%) was also a strong motivator.

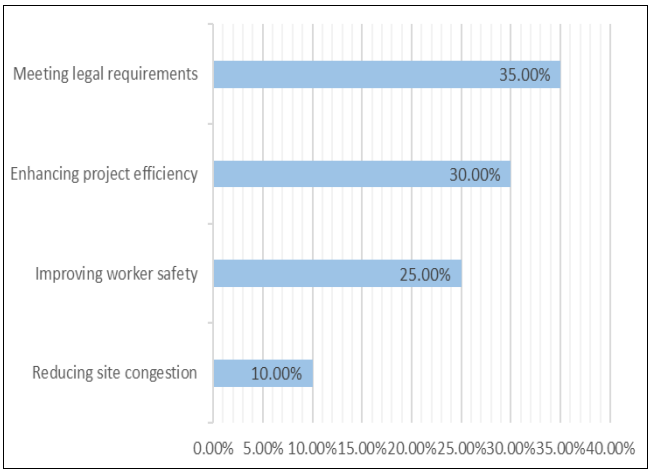

Fig 4.3.9: Primary reason for implementing ITCPs

Most teams prefer proactive strategies like contingency planning (65 mentions) and stakeholder consultations (50). Insurance coverage and scenario testing were less common.

Table 3.3.1: Types of Strategies

	Responses		Percent of Cases
	N	Percent	
Contingency planning	65	21.3%	65%
Risk assessment workshops	45	14.8%	45%
Stakeholder consultations	50	16.4%	50%
Financial reserves/budgeting	40	13.1%	40%
Insurance coverage	25	8.2%	25%
Scenario testing/simulations	30	9.8%	30%
Total	250	100.0%	250.0%

4.4 Effectiveness of Risk Management Techniques

A large proportion of respondents (75%) rated the overall effectiveness of risk management techniques as excellent. This suggests that most projects benefit from structured approaches to identifying and mitigating risks. Only a small fraction, about 5%, considered the techniques poor, reflecting limited dissatisfaction.

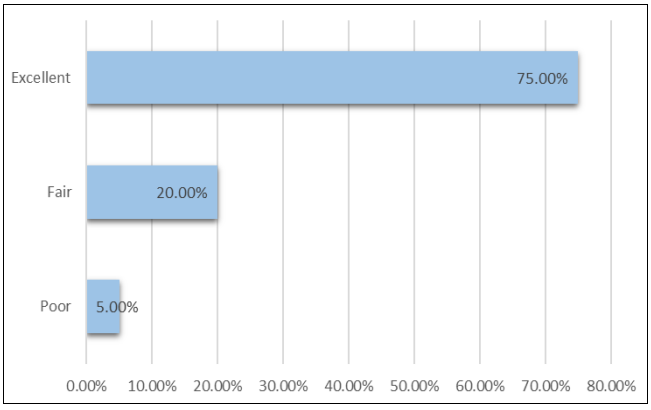

Fig 4.4.1: Overall effectiveness of risk management techniques

Among the various tools applied, risk registers were the most widely used, with 40% of respondents relying on them. SWOT analysis and FMEA followed closely, each recording 25% usage, showing they are equally valued in practice.

Monte Carlo simulations were the least utilized, at only 10%, reflecting their limited adoption.

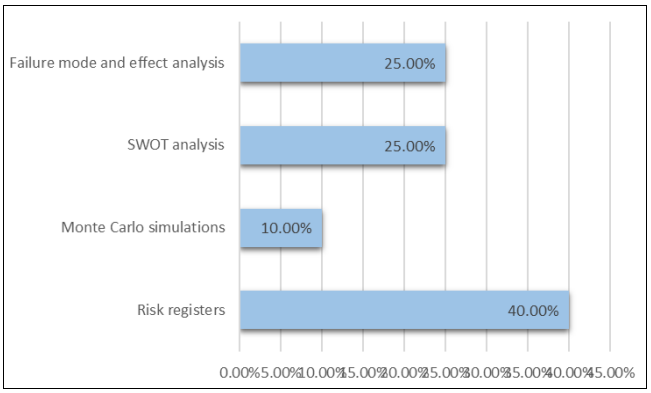

Fig 4.4.2: Most commonly used risk management tool

Workforce competency emerged as the most critical success factor, cited by 35% of respondents. Strong leadership followed at 30%, emphasizing the importance of guidance in project risk management. Government regulations, although important, were perceived as less influential, with only 15% attributing success to them.

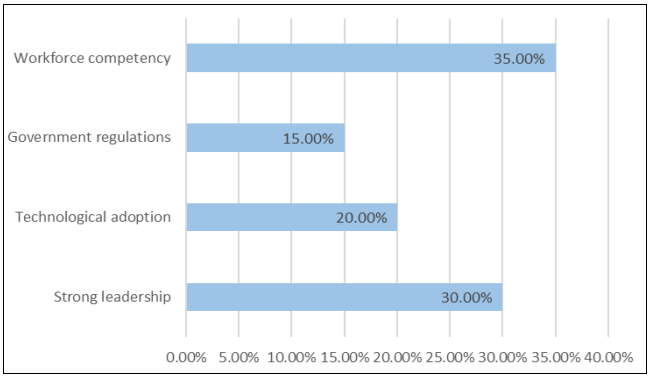

Fig 4.4.3: Factor contributing most to success

Resistance to change was identified as the leading challenge, affecting 30% of participants. High implementation costs and poor risk identification followed, each accounting for 25% of responses.

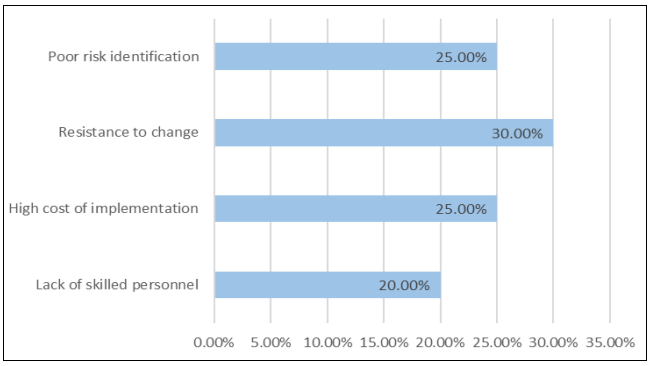

Fig 4.4.4: Most challenging aspect of implementation

Contingency planning was the most adopted technique (40%), showing organizations prioritize readiness for disruptions. Preventive measures followed at 30%, reflecting efforts to minimize risks before occurrence. Risk transfer through insurance (20%) and reactive approaches (10%) were less common, highlighting a stronger preference for proactive strategies.

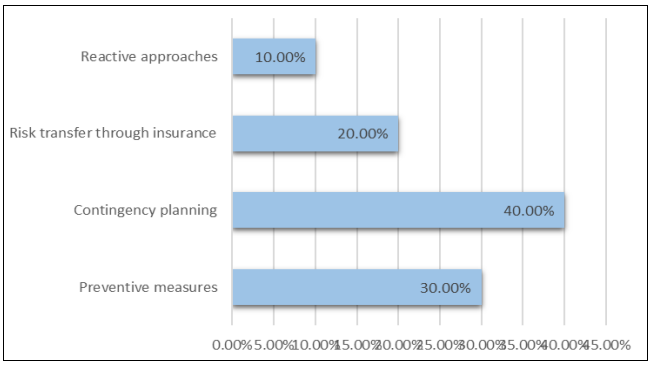

Fig 4.4.5: Most widely adopted technique

Most respondents evaluated risk management effectiveness using performance metrics (60%) and cost–benefit analysis (55%), showing a reliance on measurable outcomes. Half (50%) also emphasized stakeholder feedback as an important gauge of success. Less frequently used approaches included audit and compliance checks (35%), peer reviews (25%), and external evaluations (20%), indicating that formal and comparative assessments play a smaller role.

Table 4.4.1: Approaches Used to Evaluate Risk Management Effectiveness

	Responses		Percent of Cases
	N	Percent	
Monitoring KPIs/performance data	60	20.7%	60%
Cost–benefit analysis	55	19.0%	55%
Stakeholder feedback	50	17.2%	50%
Audit and compliance checks	35	12.1%	35%
Peer reviews/benchmarking	25	8.6%	25%
External evaluations	20	6.9	20%
Total	245	100.0%	245.0%

4.5 Challenges in Implementing Risk Management during Road Construction

Insufficient funding was identified as the biggest challenge (28%), closely followed by poor enforcement of regulations (26%).

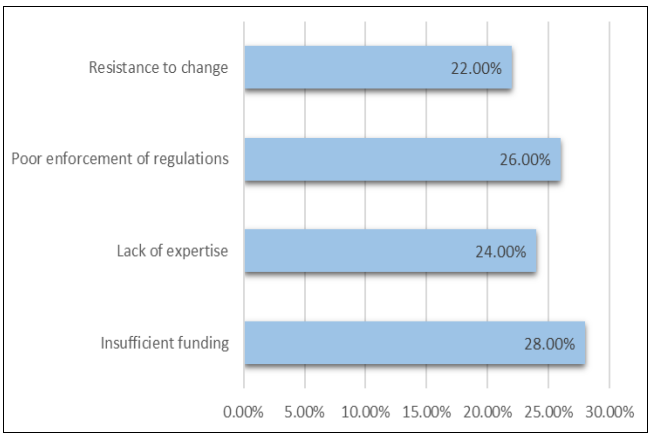

Fig 4.5.1: Key Challenges in Implementing Risk Management

Conflicting interests (30%) and poor communication (26%) were the leading barriers. This shows that disagreements and weak communication channels undermine collaboration, a

finding consistent with previous research in project management.

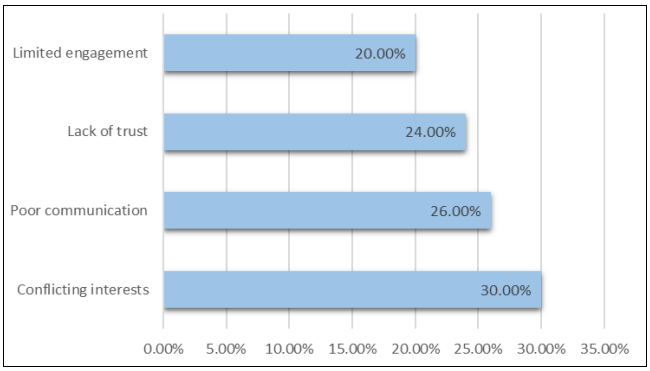

Fig 4.5.2: Major Barriers to Stakeholder Collaboration

A combined 66% of respondents indicated that legal challenges occur "frequently" or "always." This underscores the critical role of regulatory compliance in risk management and suggests that unresolved legal issues are a recurring obstacle.

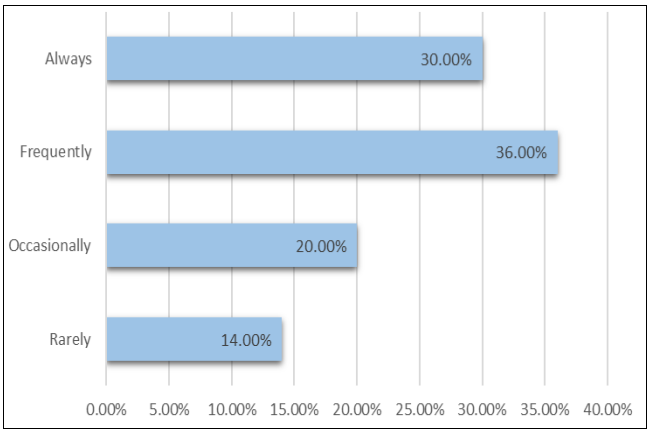

Fig 4.5.3: Frequency of Legal and Regulatory Challenges

Complexity (28%) was ranked the highest limitation, with cost and monitoring issues tied at 26% each. This indicates that frameworks are seen as too rigid and complicated to apply effectively in practical projects.

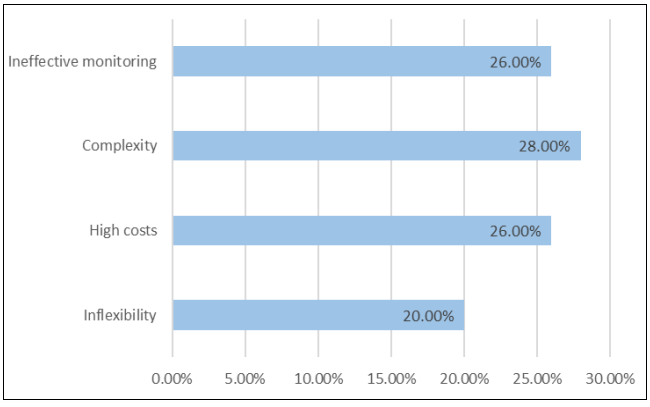

Fig 4.5.4: Limitations of Current Risk Management Frameworks

5. Discussion

The study of the Lusaka–Ndola road project examined risk mitigation strategies, their effectiveness, and the challenges in implementation, revealing that while Zambia adopts strategies similar to global best practices—including financial planning, scheduling, technical quality control, environmental safeguards, legal compliance, and safety measures—their impact is limited by weak institutional capacity, inconsistent enforcement, financial constraints, and inadequate technical expertise. Financial and time management techniques provided some buffers but were undermined by inflation, funding delays, and external disruptions, while technical and environmental measures were inconsistently applied due to poor oversight and budget prioritization. Safety interventions reduced accidents where enforced, but subcontractor non-compliance weakened results. Implementation was further challenged by corruption, political interference, cultural resistance, and technological limitations, reducing predictive and monitoring capacities. The findings indicate that risk management effectiveness depends not just on the strategies themselves but on the context in which they are applied, highlighting the need for institutional strengthening, investment in digital tools, capacity building, mainstreaming environmental and safety safeguards, and cultural and regulatory reforms to improve project outcomes and adapt global risk management models to local realities.

6. Conclusion

The study set out to evaluate the effectiveness of risk management strategies in project management with a focus on the Lusaka–Ndola Road project. The findings show that road construction projects are exposed to diverse risks, with technical and safety risks being the most dominant, followed by environmental and financial challenges. These risks were found to have direct implications on project timelines, costs, and workforce safety, making them central to effective project delivery. The study further established that mitigation strategies such as stakeholder collaboration, financial planning, safety training, compliance with environmental regulations, and quality control are widely applied and perceived as effective in reducing risks. Proactive approaches like contingency planning and regular risk assessments were also highlighted as critical in strengthening project resilience. The majority of respondents rated the overall effectiveness of these strategies as excellent, underscoring their positive role in minimizing worker accidents, avoiding financial losses, reducing delays, and ensuring legal compliance. However, implementation challenges remain significant. Insufficient funding, weak policy enforcement, legal hurdles, and poor stakeholder collaboration were the most common obstacles identified. Frameworks were also perceived as overly complex, limiting their practicality in road construction projects. Suggested solutions included increasing resource allocation, strengthening training and capacity-building, enhancing policy enforcement, and improving communication among stakeholders.

7. Acknowledgement

I am profoundly thankful to the Divine Creator, the ultimate source of life, knowledge, and insight, for guiding and blessing me throughout this research journey. I extend my heartfelt gratitude to Dr. Chibomba Kelvin, my research supervisor, for his unwavering support, guidance, and patience. It has been an honor to work under his mentorship, and I am deeply appreciative of the valuable insights and wisdom he has shared with me. His expertise and dedication

have greatly influenced the outcomes of this project.

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