Examining Effectiveness of Risk Management Processes in Fiber Projects: A Case Study of Lumwana Mine Fiber Optic Project

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Publication Date: 2026/01/22

Abstract: This study examined the effectiveness of risk management processes employed in the Lumwana Mine Fiber Optic Project, focusing on the identification, assessment, and mitigation of risks. A case study exploratory design was utilized, drawing on a mixed-methods approach to provide both quantitative and qualitative insights. Primary data was collected through structured questionnaires and interviews with project managers, technical staff, and stakeholders involved in the implementation of the fiber optic project. Quantitative data was analyzed using STATA software, applying descriptive statistics such as frequencies, percentages, and means to summarize trends and patterns. Chi-square analysis was used to assess associations between risk management variables and project performance indicators. Qualitative data was analyzed thematically to contextualize and deepen understanding of study findings. Findings indicate that risk management is centralized, with the Project Management department and Project Manager primarily responsible for risk identification, documentation, and communication, using risk registers (40%), brainstorming (24%), and expert consultations (20%), while spreadsheets (50%) dominate tracking. Risk management is most emphasized during implementation, with technical risks (32%) prioritized. Key risks affecting project execution include technical failures (36%), supply delays (32%), budget overruns (40%), environmental hazards such as dust pollution (24%), and human-related issues like skill shortages (36%). Statistically significant associations were found between technical risks and supplier delays, and between financial constraints and perceived subcontractor performance risks ($p < 0.001$). Mitigation strategies rely on expert consultation, stakeholder workshops, preventive maintenance, budget reserves, contingency planning, and early detection, though gaps exist in capturing lessons learned and consistently applying procedures. Challenges include limited expertise (32%), inadequate training (40%), time constraints (28%), financial limitations (36%), poor communication, and organizational bureaucracy. The study highlights the need for structured documentation, formal communication channels, capacity building, and proactive risk mitigation to enhance project performance and continuity. The study recommends strengthening supplier engagement through improved evaluation and monitoring, enhancing financial planning with tighter budget controls and clear subcontractor agreements, and simplifying risk management procedures for better accessibility.

Keywords: *Risk Management, Project Performance, Fiber Optic Infrastructure, Mitigation Strategies, Operational Challenges.*

How to Cite: Michael Mzumara; Chibomba Kelvin (2026) Examining Effectiveness of Risk Management Processes in Fiber Projects: A Case Study of Lumwana Mine Fiber Optic Project. *International Journal of Innovative Science and Research Technology*, 11(1), 1388-1411. https://doi.org/10.38124/ijisrt/26jan635

I. INTRODUCTION

➢ *Background*

Risk management is a systematic process of identifying, assessing, and mitigating risks to minimize their impact on project objectives (Siraj, 2019). In fiber optic projects, risk management involves anticipating challenges such as design errors, budget overruns, supply chain disruptions, environmental factors, and technological failures. Effective risk management ensures that such projects are completed within scope, budget, and timelines while maintaining quality standards (Van, 2019).

Globally, the demand for reliable and high-speed internet connectivity has surged, driven by the increasing adoption of digital technologies, cloud computing, and the Internet of Things (IoT) (Burgstaller, 2024). Fiber optic networks are seen as the backbone of modern digital infrastructure, with countries like the United States, China, and South Korea investing heavily in nationwide fiber deployment.

In many developing countries, including Zambia, fiber optic projects are pivotal in bridging the digital divide and enabling access to essential services such as e-health, e-education, and e-commerce (Liswaniso, 2024). Despite the

ISSN No: -2456-2165 https://doi.org/10.38124/ijisrt/26jan635

potential benefits, local fiber projects often face unique risks, including inadequate funding, lack of skilled labor, theft of materials, and difficulties in obtaining environmental clearances. These challenges are compounded by weak enforcement of regulations and limited adoption of advanced risk management practices, leading to project delays and cost overruns (Longwe, 2022).

The consequences of inadequate risk management in fiber projects extend beyond financial losses. Delayed or failed projects can hinder socioeconomic development, limit access to essential services, and erode public trust in infrastructure initiatives (Ofem, 2020). On the other hand, effective risk management enhances project outcomes, strengthens investor confidence, and supports the achievement of national and global digital transformation goals (Mukalula, 2020).

➢ *Statement of the Problem*

Risk management is a critical component of fiber optic projects, particularly in complex and high-risk environments such as mining operations (Murry, 2022). In Lumwana Mine, where fiber optic infrastructure is essential for communication, automation, and data transmission, the effectiveness of risk management processes remains a significant concern. Despite existing risk management frameworks, fiber optic projects in mining environments continue to face technical challenges, environmental hazards, regulatory constraints, financial limitations, and operational disruptions that affect project timelines, budgets, and overall success (Zhang, 2023). In Zambia, mining operations have been identified as high-risk environments due to geological uncertainties, extreme weather conditions, and dynamic operational activities (Nachalwe, 2020). Furthermore, while international best practices in risk management for fiber optic projects emphasize proactive risk identification, mitigation strategies, and adaptive project management, there is limited empirical research on how effectively these practices are applied within Zambian mining projects (Akhwaba, 2020).

- *General Objectives*

To examine the effectiveness of risk management processes in the Lumwana Mine fiber optic project.

- *Specific Objectives*

✓ To assess the current risk management practices employed in the Lumwana Mine fiber optic project.
✓ To identify the key risks affecting the successful implementation of the fiber optic project at Lumwana Mine.
✓ To analyze the effectiveness of the risk identification, assessment, and mitigation strategies used in the project.

➢ *Conceptual Framework*

The conceptual framework for this study explored the relationship between risk management processes and project outcomes in the Lumwana Mine fiber optic project. The study identified risk management processes as the independent variables, which include risk identification, risk assessment, and risk mitigation. Risk identification involves methods such as brainstorming, expert judgment, and the analysis of historical data to pinpoint potential risks (Nachalwe, 2020). Risk mitigation focuses on strategies to minimize or eliminate risks, including preventive measures and contingency planning (Koulinas, 2019). The dependent variables in this framework are the project outcomes, which include project cost, timeline, and quality. Project cost reflects the financial performance and adherence to budget, while the timeline focuses on completing the project within the scheduled timeframe. Project quality evaluates conformance to technical and performance standards. The relationship between the independent and dependent variables is moderated by factors such as the project environment, stakeholder engagement, and resource availability, which can either enhance or hinder the effectiveness of risk management processes (Williams, 2020).

II. LITERATURE REVIEW

➢ *Risk Management Practices Employed in Mine Fiber Optic Project*

Ngugi's (2024) study focused on 125 construction projects in Nairobi City County, examining the impact of optimal funding for fibre optic projects in Kenya. The findings revealed that project financing, top management support, stakeholder engagement, and project monitoring significantly and positively influenced the performance of fibre optic infrastructure projects (Ngugi, 2024).

Ofem (2021) explored the causes of delays in construction project delivery in rapidly developing third-world nations, particularly Nigeria. Findings revealed that inadequate project planning was the most significant cause of delays, followed by financial issues such as fund miss allocation, corruption, and mismanagement. Time and budget overruns were identified as the primary consequences of project delays (Ofem, 2021).

Siraj (2019) explored commonly used risk identification tools and techniques, risk classification methods, and prevalent risks in construction projects. This study highlights the absence of a comprehensive systematic review and content analysis on risk identification in construction projects, providing valuable insights for researchers and industry practitioners on the most common risks affecting the sector (Siraj, 2019).

➢ *Key Risks Affecting the Successful Implementation of the Fiber Optic Project*

Cai (2024) conducted a systematic study on rockburst risk in underground mining, analyzing the key influencing factors, risk assessment methods, and various control and mitigation strategies. The research presents a comprehensive range of risk control and mitigation strategies, focusing on reducing rockburst hazards, excavation vulnerability, and exposure. It discusses strategic engineering controls such as mine design and mining sequencing, along with tactical measures like ground pre-conditioning and rock support. Additionally, administrative controls, including evacuation

ISSN No: -2456-2165 https://doi.org/10.38124/ijisrt/26jan635

procedures, re-entry protocols, and the use of mechanized equipment, are examined (Cai, 2024).

Elbashbishy (2024) addressed this knowledge gap by analyzing data from 67 construction projects to identify key labor-intensive trades. The findings identified 10 key labor-intensive trades, with plumbing and electrical work experiencing the most severe skilled labor shortages, while finishing trades such as plastering, painting, flooring, and waterproofing had the least. A significant correlation was found between high union membership and the availability of skilled workers in three trades iron working, flooring, and waterproofing.

- *Effectiveness of the Risk Identification, Assessment, and Mitigation Strategies Used in Optic Fiber Projects*

Risk identification, assessment, and mitigation are foundational steps in the successful execution of a fiber optic project, particularly in complex and high-stakes environments like mines (Zvarivadza, 2024). A systematic approach to risk management ensures that the project proceeds smoothly, achieving its objectives while adhering to safety and environmental standards. Below is an expanded discussion of these critical components (Latilo, 2024).

The first stage in risk management is identifying potential threats that could impact the project's success. This involves a thorough analysis of the project environment, stakeholders, and historical data from similar endeavors (Zhang, 2023). One of the primary tools for risk identification is conducting site surveys and inspections. These inspections also reveal logistical risks, such as limited accessibility or restricted working hours due to mining operations (Zvarivadza, 2023). Another essential method is stakeholder input, where project managers, engineers, regulators, and community representatives collaborate to identify potential risks from their unique perspectives (Dua, 2021). Engaging stakeholders early ensures a holistic understanding of the risks and helps foster cooperation throughout the project lifecycle (Erkul, 2020).

III. RESEARCH METHODOLOGY

- *Research Design*

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

- *Target Population*

The target population for this study consisted of Project managers and site engineers at Lumwana mine.

- *Sample Size*

The sample size for this study consisted of 50 respondents.

- *Sampling*

Convenience sampling approach was used to select the study sample.

- *Data Collection Methods*

The study made use of a semi-structured questionnaire, which included both closed-ended and open-ended questions. Primary data was gathered through administration of questionnaires.

IV. RESULT PRESENTATION

- *Presentation of Results on Background Characteristics of the Respondents*

Out of the 50 respondents, 70% were male and 30% were female. This shows that the majority of participants in the study were male.

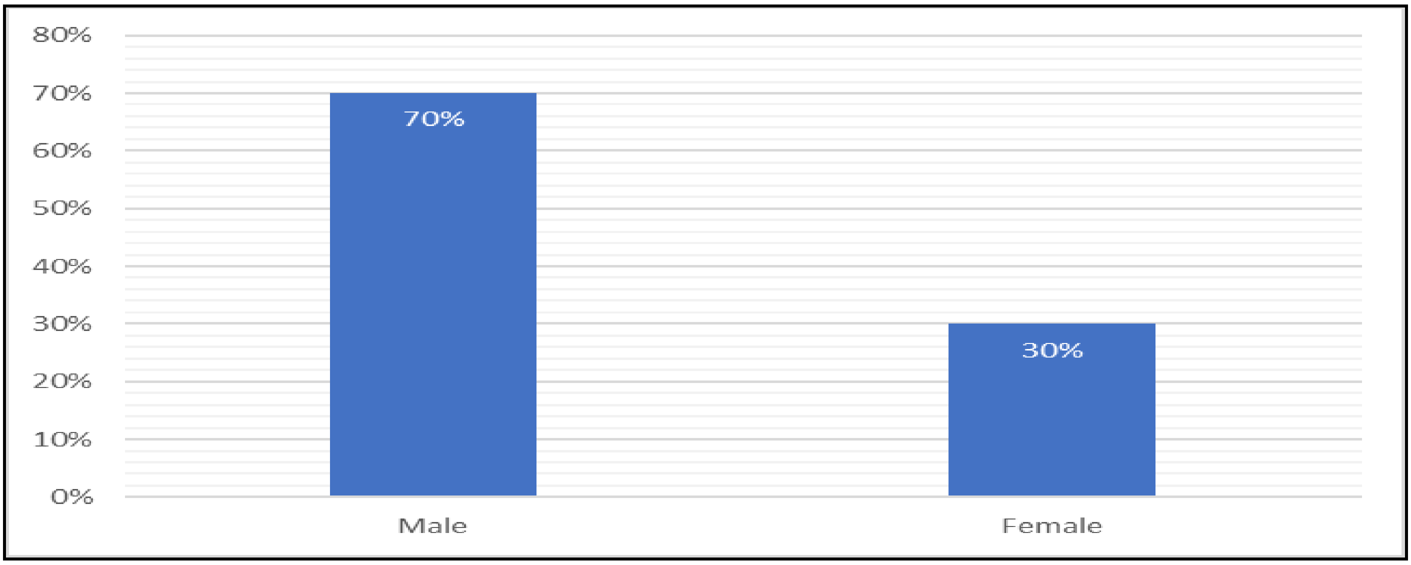

Fig 1 Participant's Gender

The age distribution showed that 40% of respondents were aged between 31–40 years, and another 40% were aged between 41–50 years. A smaller proportion, 10%, were aged between 22–30 years, while another 10% were above 50 years. Most participants were therefore between 31 and 50 years old.

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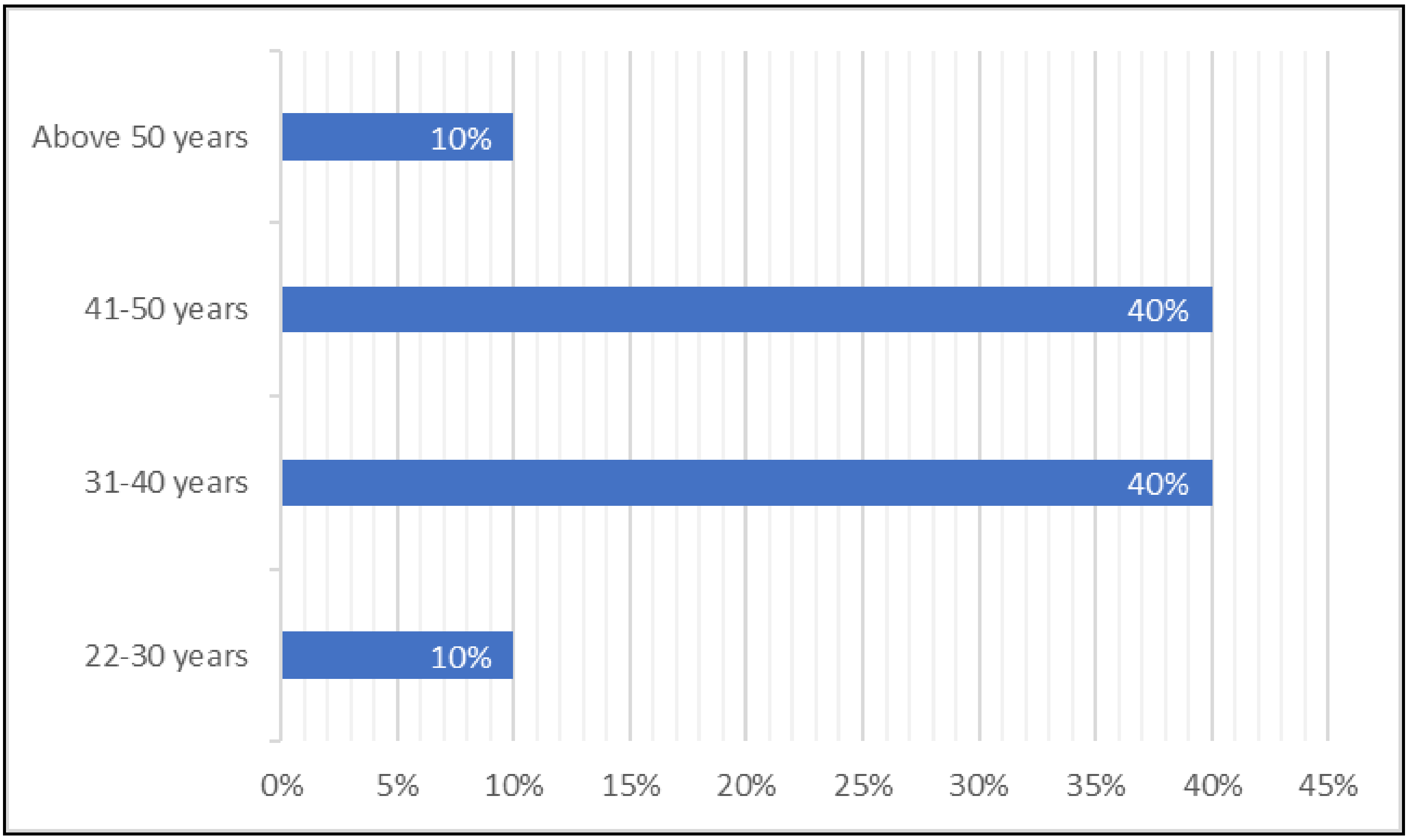

Fig 2 Age

Most respondents (80%) held a Bachelor's degree. An equal proportion of participants had either a higher education diploma/certificate or a Master's degree, each representing 10%.

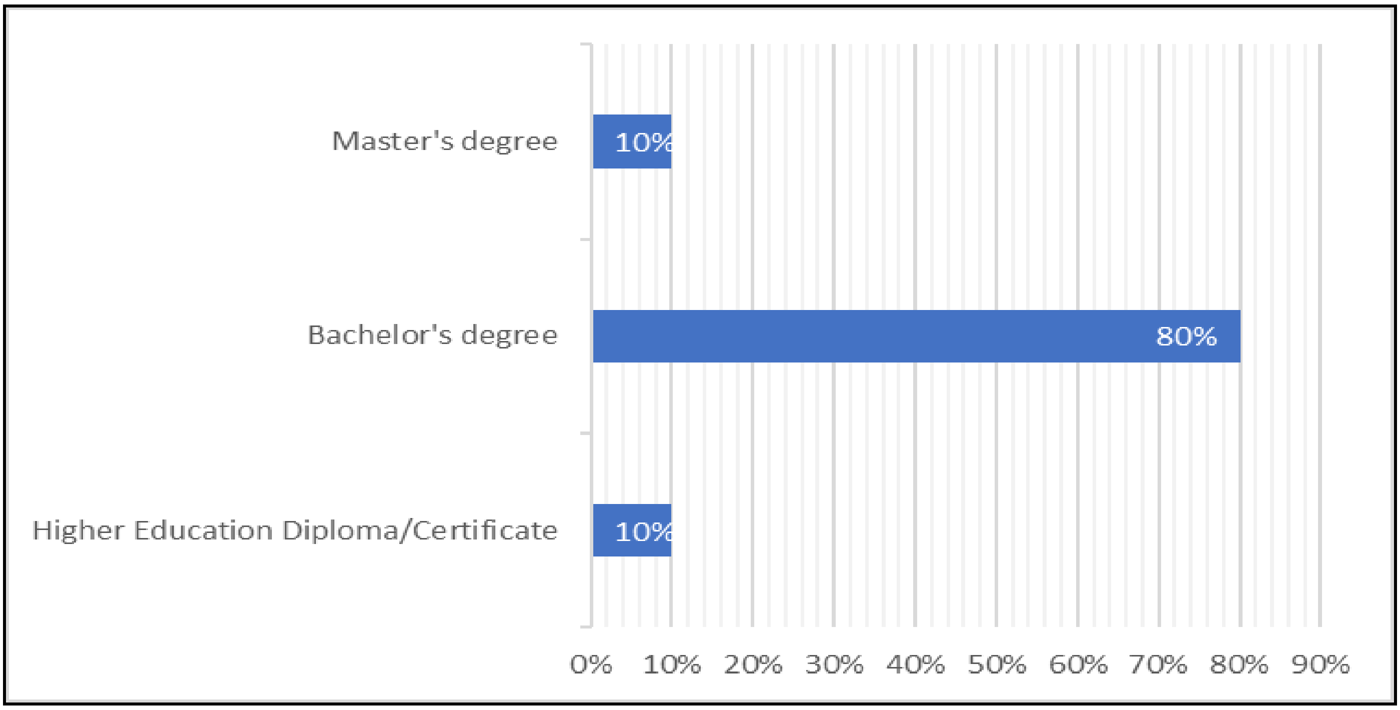

Fig 3 Education Level

- ➢ *Assessment of Current Risk Management Practices in the Lumwana Mine Fiber Optic Project*

The findings indicate that the Project Management department is the main custodian of risk management activities, with 54% of respondents confirming this role. Engineering and Procurement contribute less, at 16% and 12% respectively, while IT 18%.

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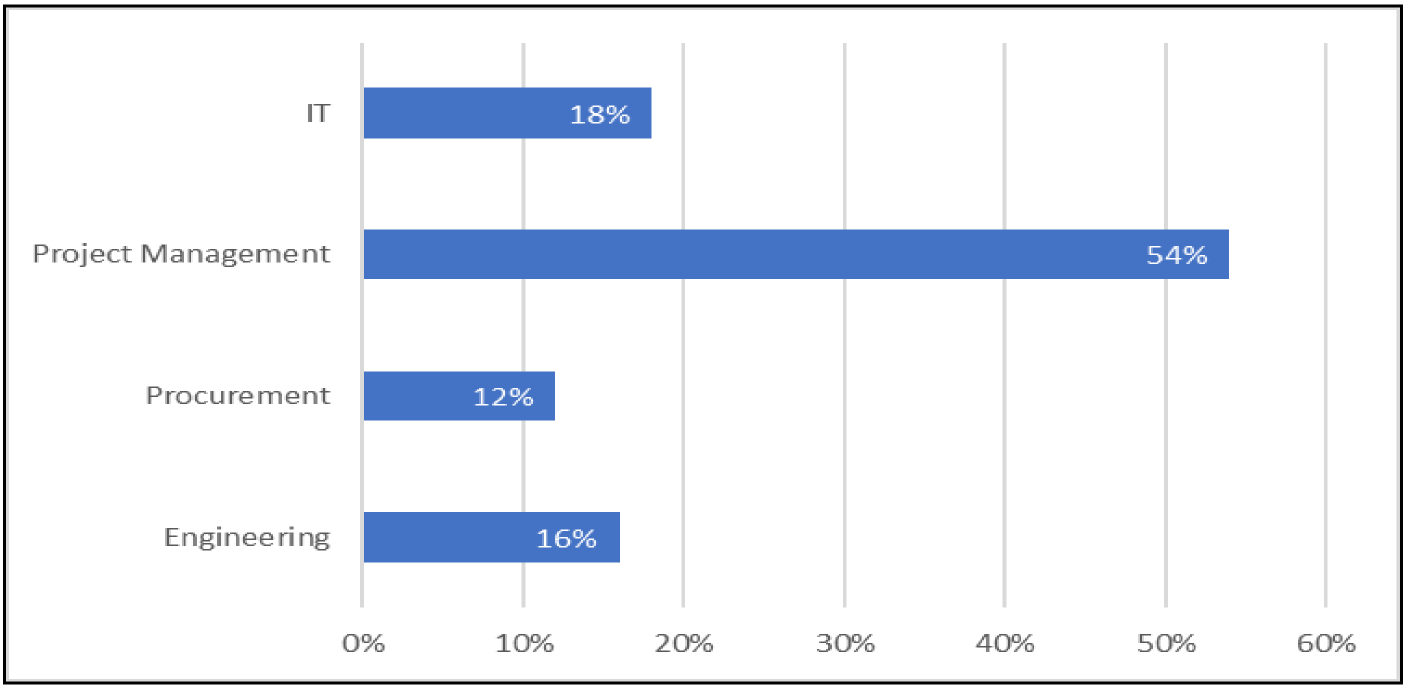

Fig 4 Departmental Responsibility for Risk Management

The risk register is the primary method for risk identification (40%), with brainstorming sessions (24%) and expert consultations (20%) also used. Checklists are the least utilized method (16%). This demonstrates a formalized approach through documented registers, supplemented by expert input, but with limited use of systematic procedural tools like checklists.

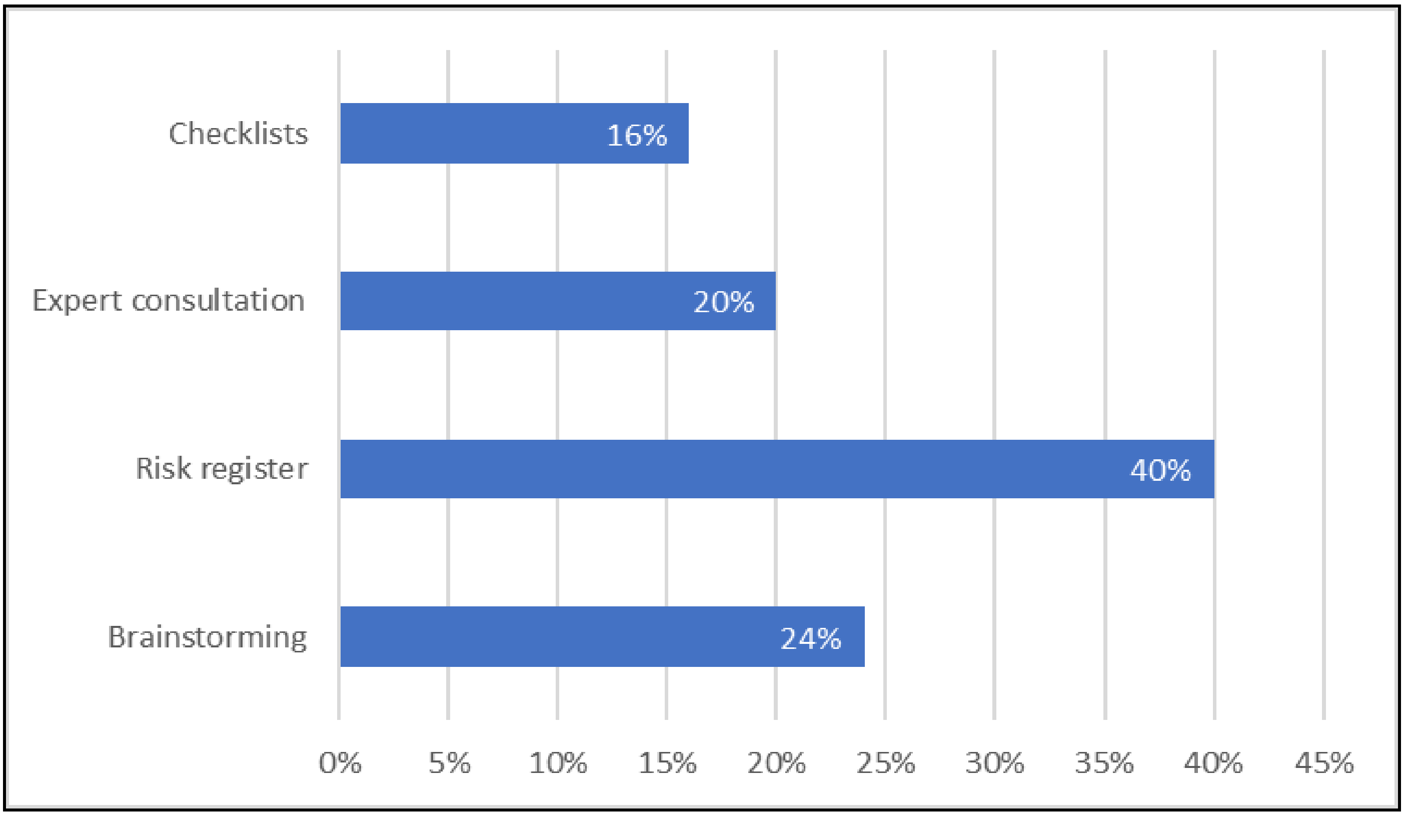

Fig 5 Methods Used for Risk Identification

The Project Manager is the main individual responsible for documenting risks (60%), while Risk Officers handle 20%. Site Supervisors and Contractors contribute minimally (10% each).

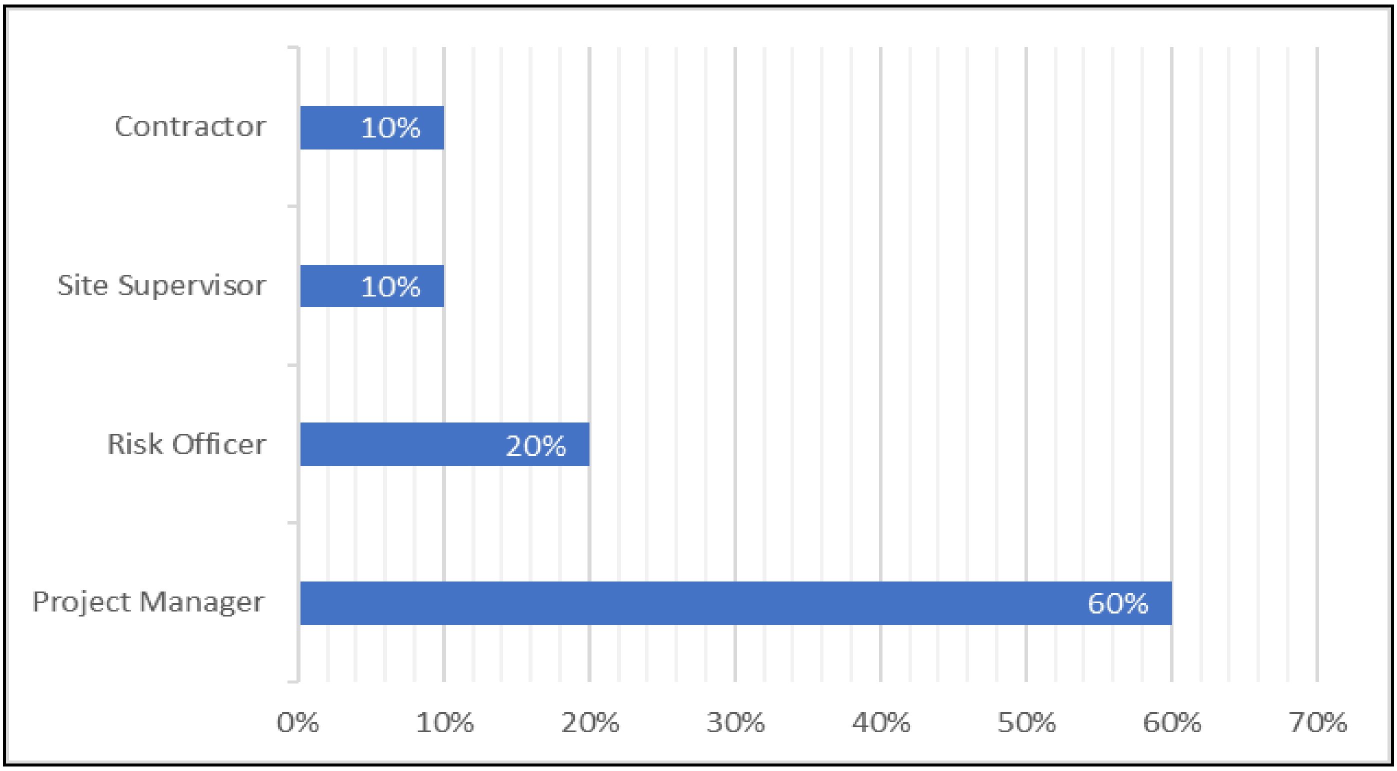

Fig 6 Responsibility for Documenting Identified Risks

Communication is predominantly conducted through meetings (40%) and regular reports (36%), while emails (14%) and informal discussions (10%) are less frequent.

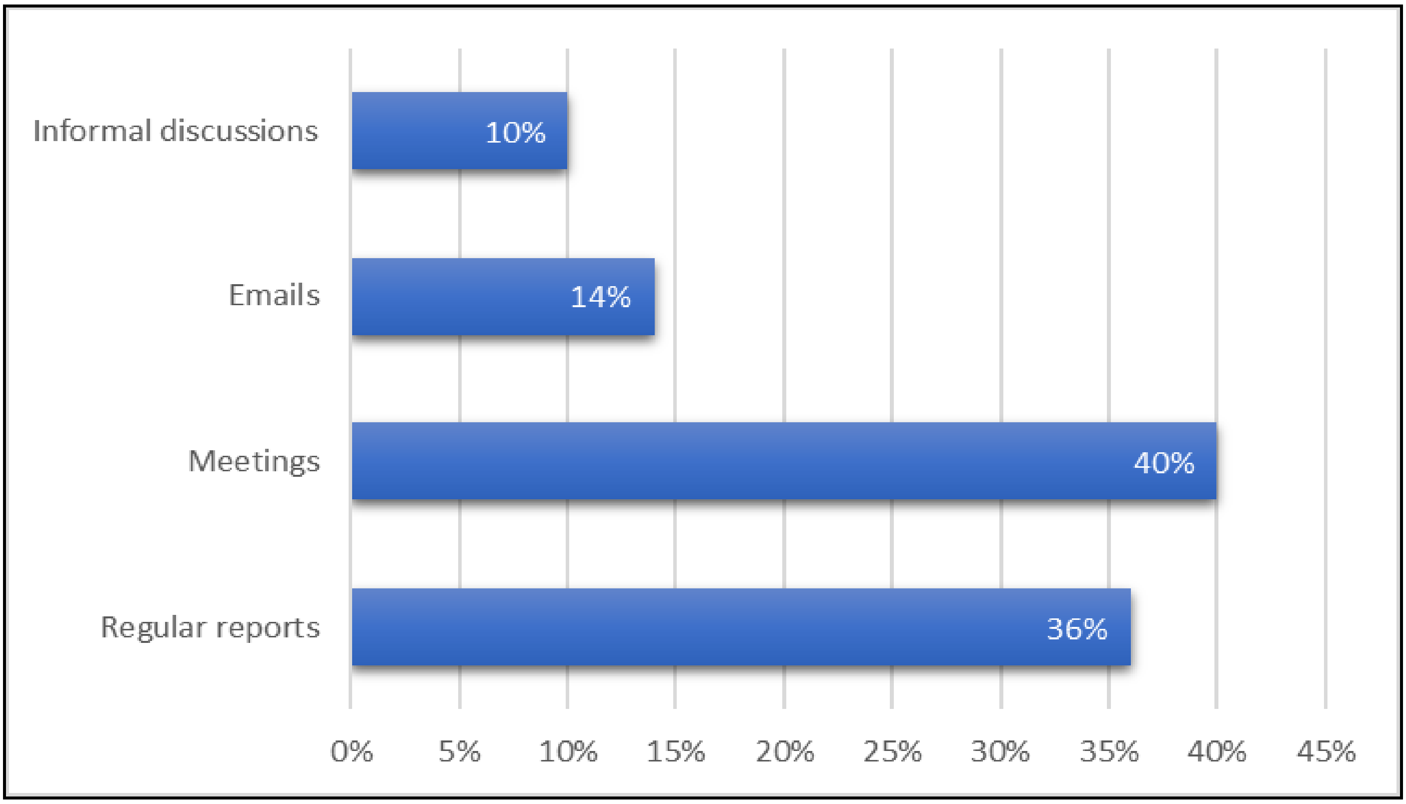

Fig 7 Communication of Risks Among Stakeholders

The majority of respondents (50%) use spreadsheets to track risk progress, followed by project management software (30%), while manual reports and (20%).

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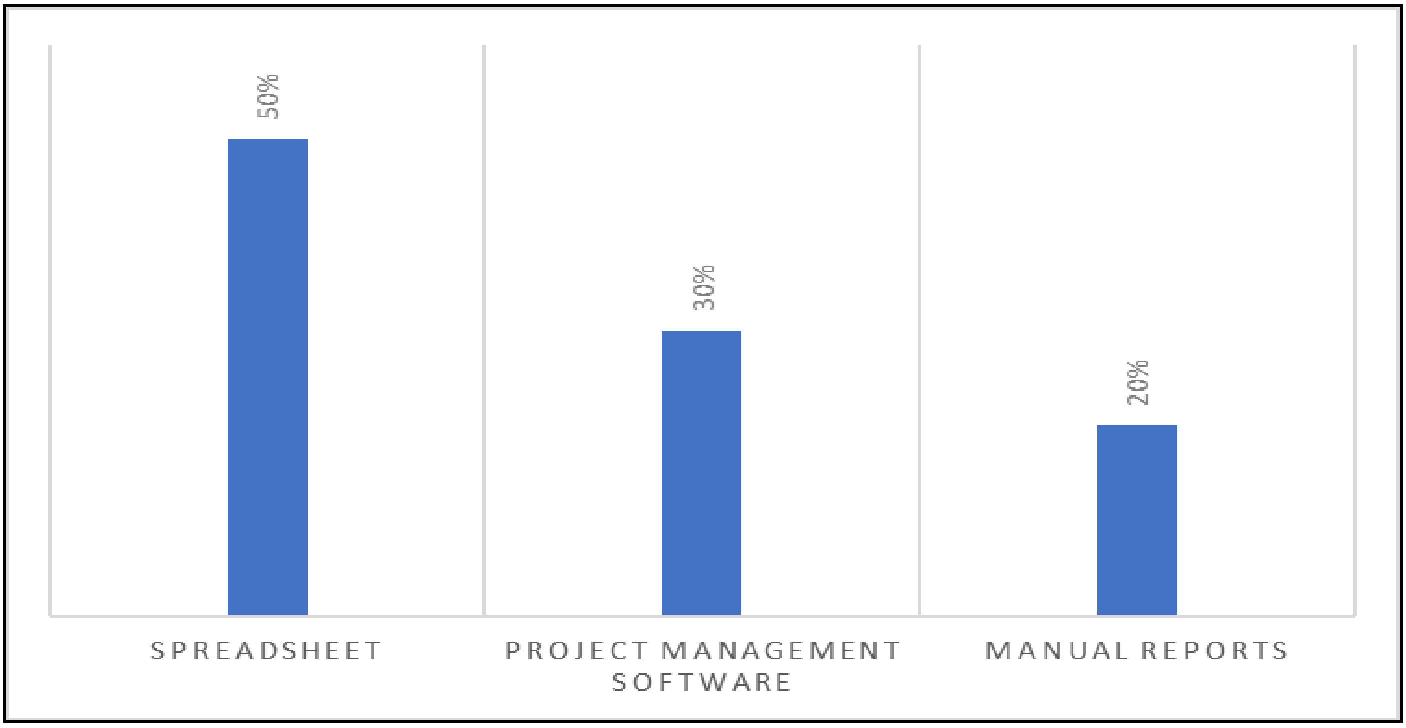

Fig 8 Tools Used for Tracking Risk Progress

Risk management is most emphasized during the implementation stage (40%), followed by the planning stage (28%), with less focus during monitoring (20%) and closure (12%). This reflects a reactive tendency where risk management efforts peak when project activities are in progress rather than being consistently integrated throughout the project lifecycle.

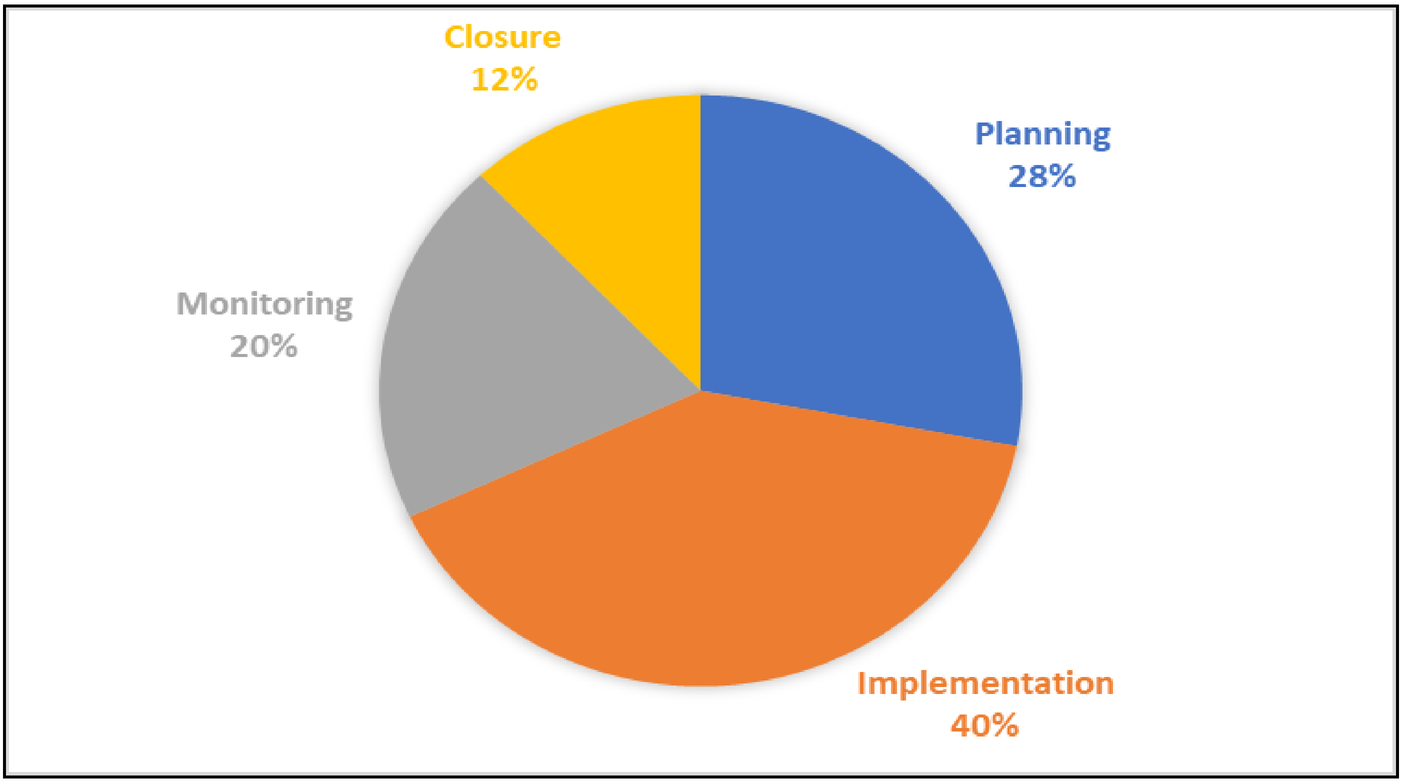

Fig 9 Project Stage Emphasis on Risk Management Activities

Technical risks (32%) receive the most frequent attention, followed by financial and safety risks (24% each), and environmental risks (20%). This indicates that the project prioritizes operational and technical uncertainties, though environmental risks may require increased attention to meet compliance and sustainability standards.

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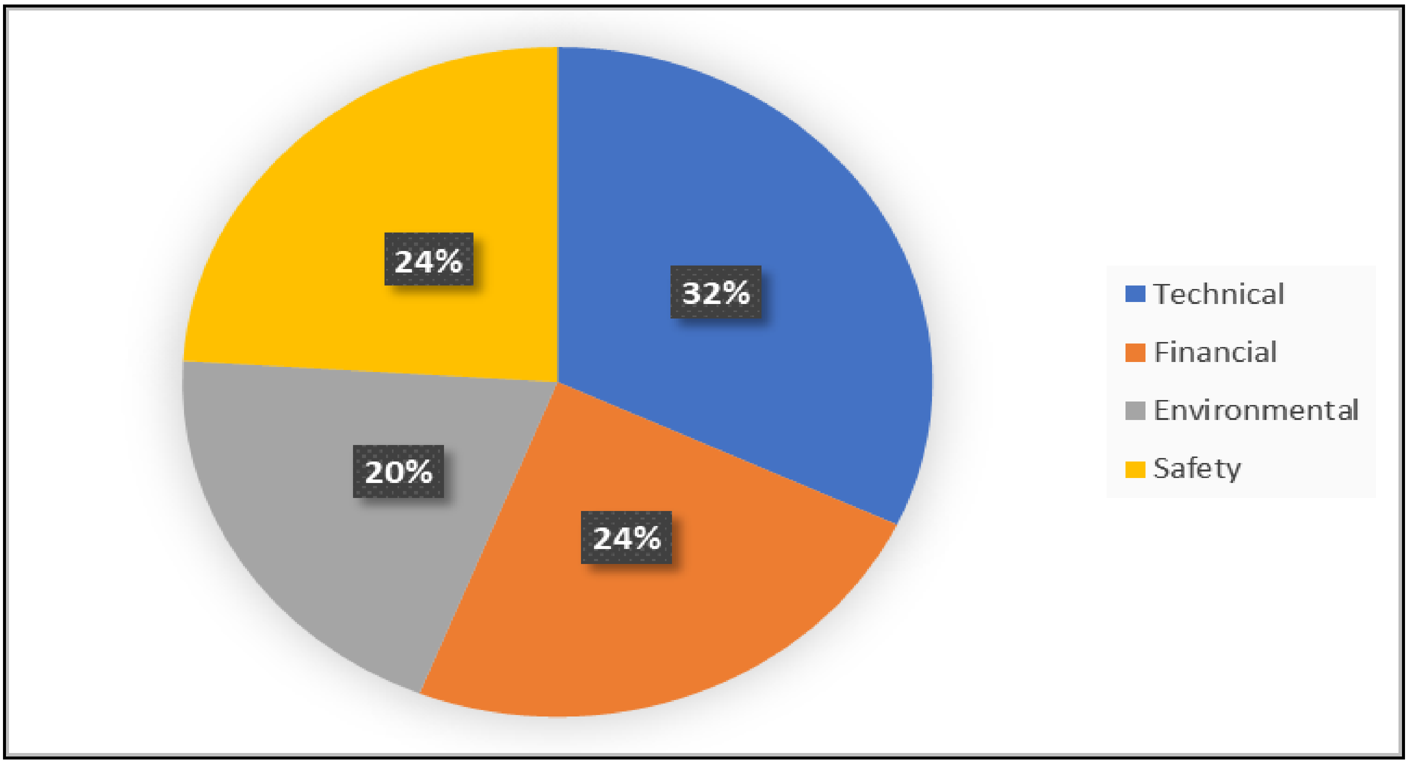

Fig 10 Categories of Risks Most Frequently Reviewed

Technical risks are considered the most critical to the project's success, identified by 100% of respondents. Human-related risks follow closely, with 88% highlighting their impact. Environmental risks are also significant (76%), while financial and regulatory risks are seen as less critical, each at only 6%.

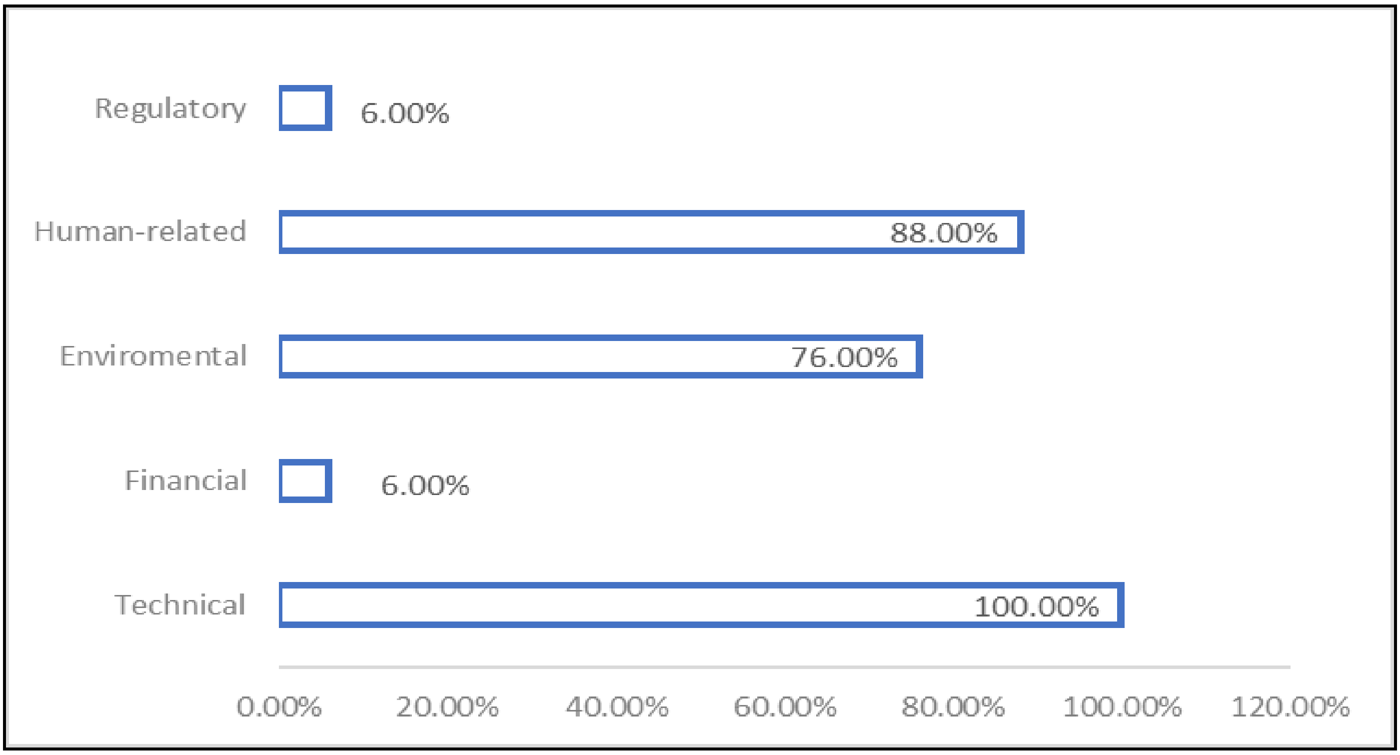

Fig 11 Most Critical Type of Risk to Project Success

Roles are mostly delegated on an ad hoc basis (44%), while 36% follow predefined policies, 12% are assigned by the manager, and 8% have undefined roles. This shows inconsistency in role assignment, suggesting potential confusion or gaps in accountability for risk-related responsibilities within the project team.

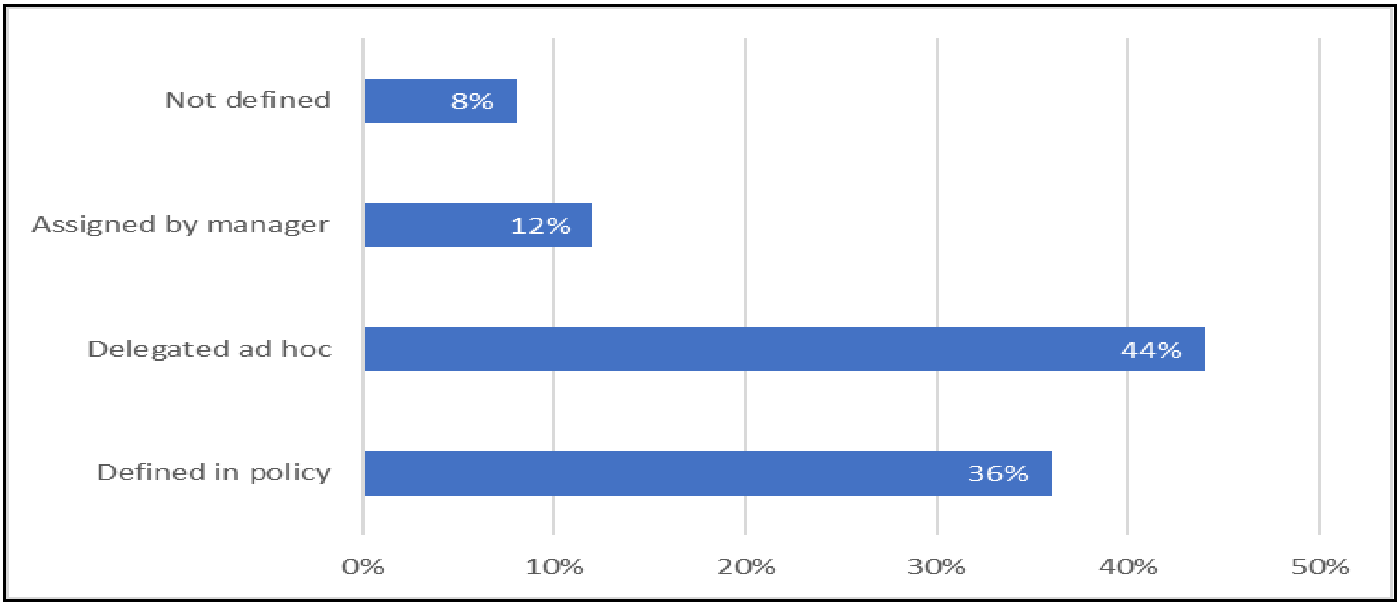

Fig 12 Assignment of Risk Management Roles in the Project Team

A chi-square test was conducted to examine the relationship between the extent to which standard risk management procedures are documented and followed and the effectiveness of communication of risk responsibilities among team members. The results showed a statistically significant association (χ^2 = 62.500, df = 6, p = .000), indicating that better documentation of procedures is linked to more effective communication. The likelihood ratio test also confirmed this association (p = .000), and a significant linear-by-linear association (p = .021) suggests a trend where increased documentation corresponds with improved communication.

Table 1 The Relationship Between the Extent to Which Standard Risk Management Procedures are Documented and Followed and the Effectiveness of Communication of Risk Responsibilities Among Team Members

	Value	**df**	**Asymp. Sig. (2-sided)**
Pearson Chi-Square	62.500[a]	6	.000
Likelihood Ratio	66.319	6	.000
Linear-by-Linear Association	5.337	1	.021
N of Valid Cases	50		

Respondents who reported that procedures were "always" followed rated communication as either "very effective" (n = 30) or "ineffective" (n = 5), while lower levels of documentation corresponded with more varied and less favorable communication ratings.

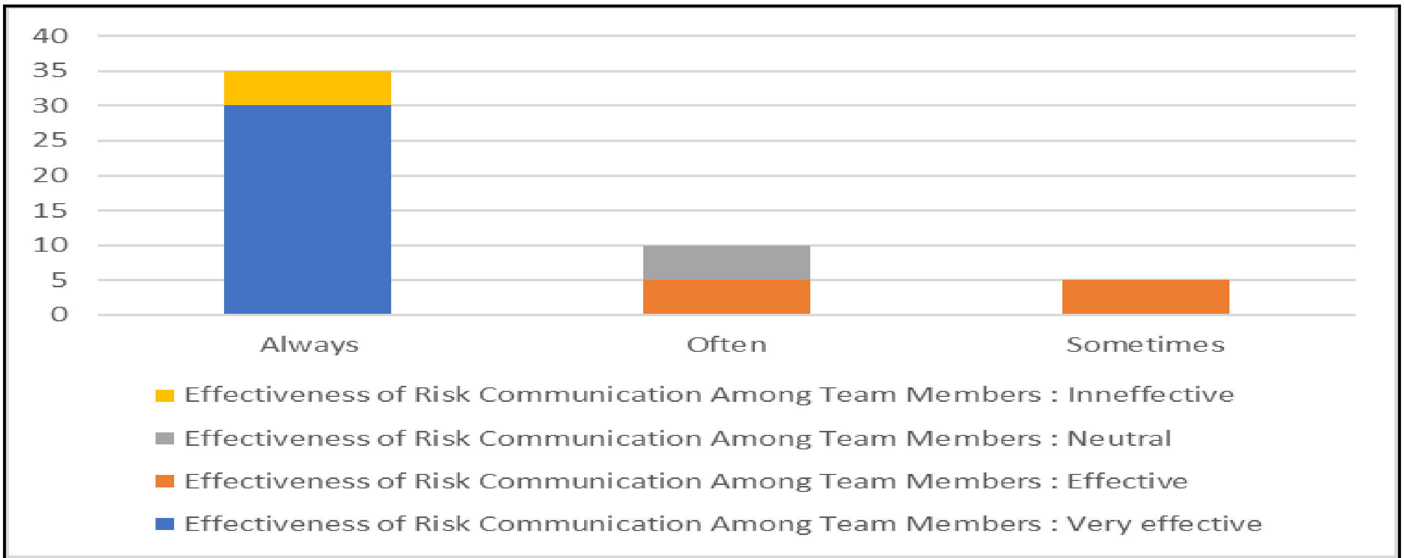

Fig 13 The Relationship Between the Extent to Which Standard Risk Management Procedures are Documented and Followed and the Effectiveness of Communication of Risk Responsibilities Among Team Members

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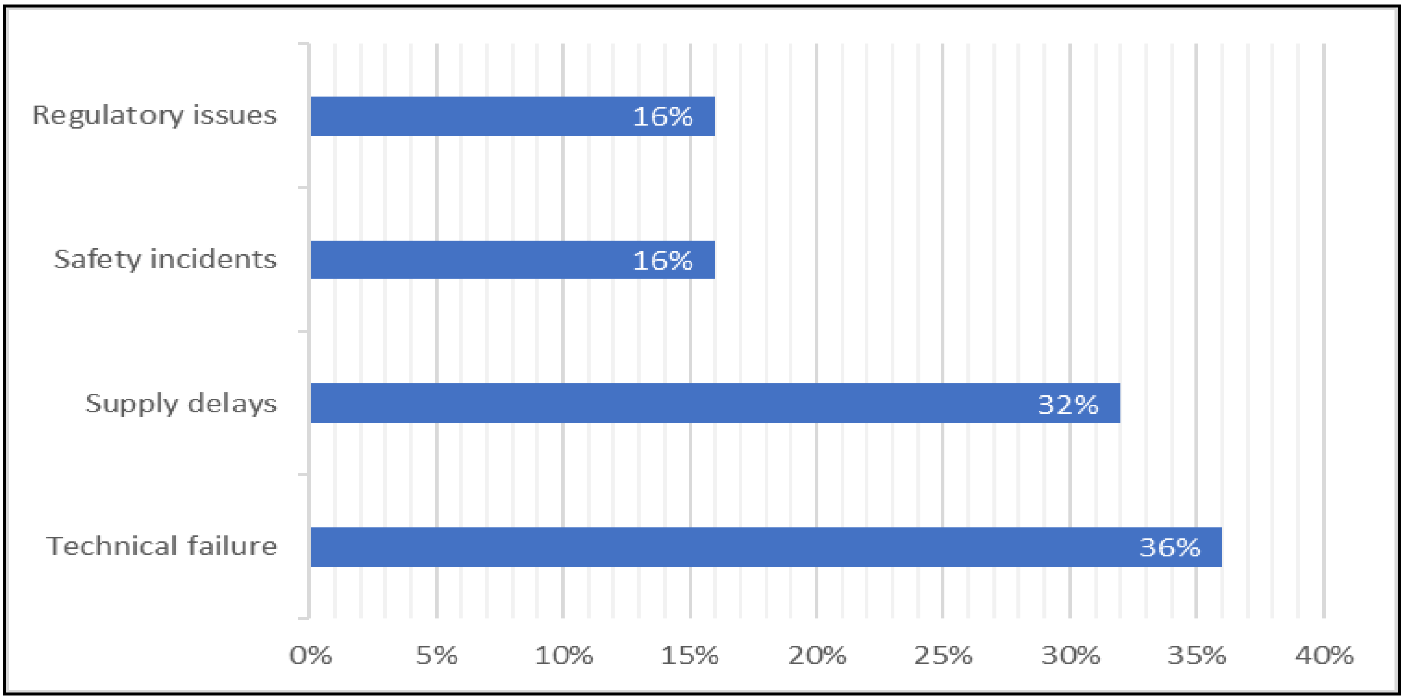
➢ *Key Risks Affecting Project Implementation*

Technical failures are identified as the primary risk affecting project timelines, with 36% of respondents indicating this impact. Supply delays follow closely at 32%, while safety incidents and regulatory issues are each reported by 16%.



Figu 14 Type of Risk with Greatest Impact on Project Timelines

Project delays are most frequently caused by workforce shortages (28%) and funding delays (28%), followed by equipment breakdowns (24%) and weather conditions (20%).

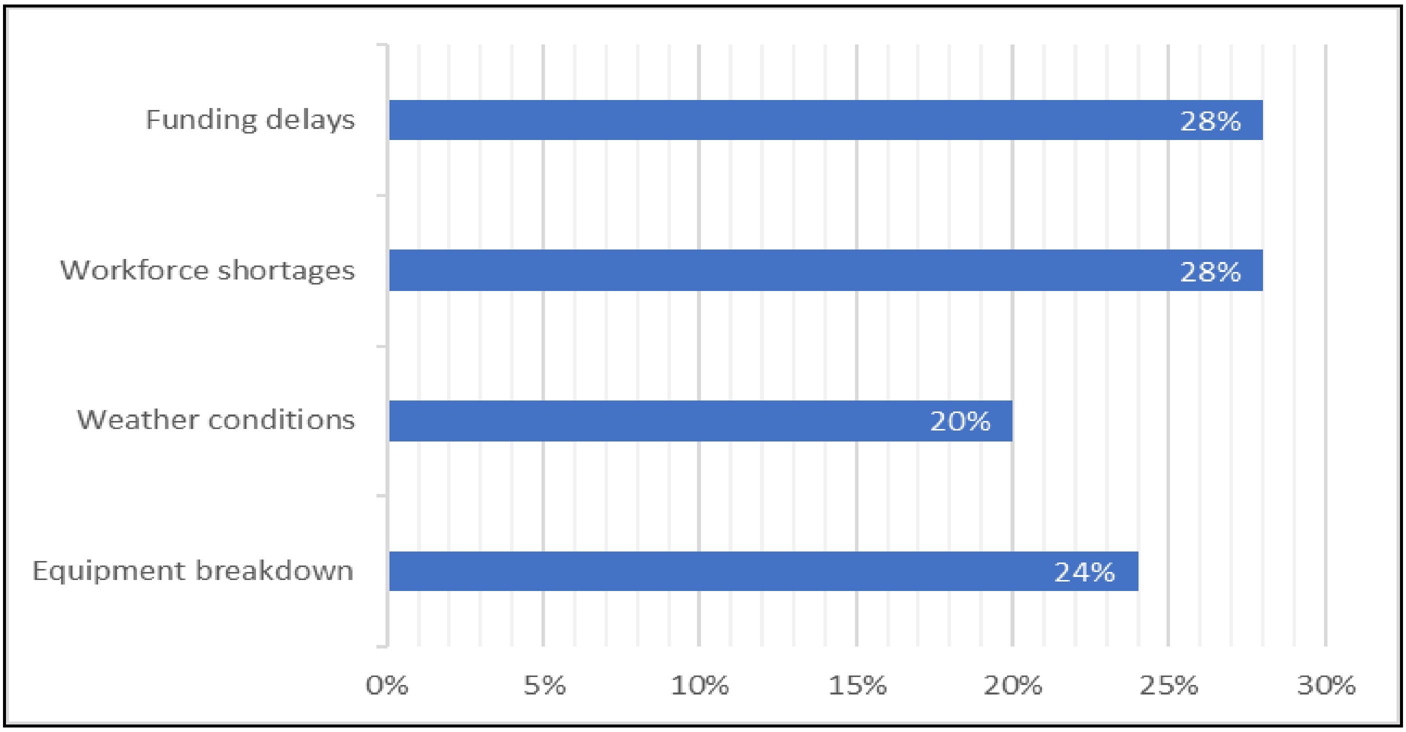


Fig 15 Most Frequent Source of Project Delays

Budget overruns are the most significant financial risk, affecting 40% of respondents. Payment delays and cost estimation errors each account for 24%, while currency fluctuations impact 12%. This highlights the critical importance of cost control and accurate financial planning to maintain project stability.

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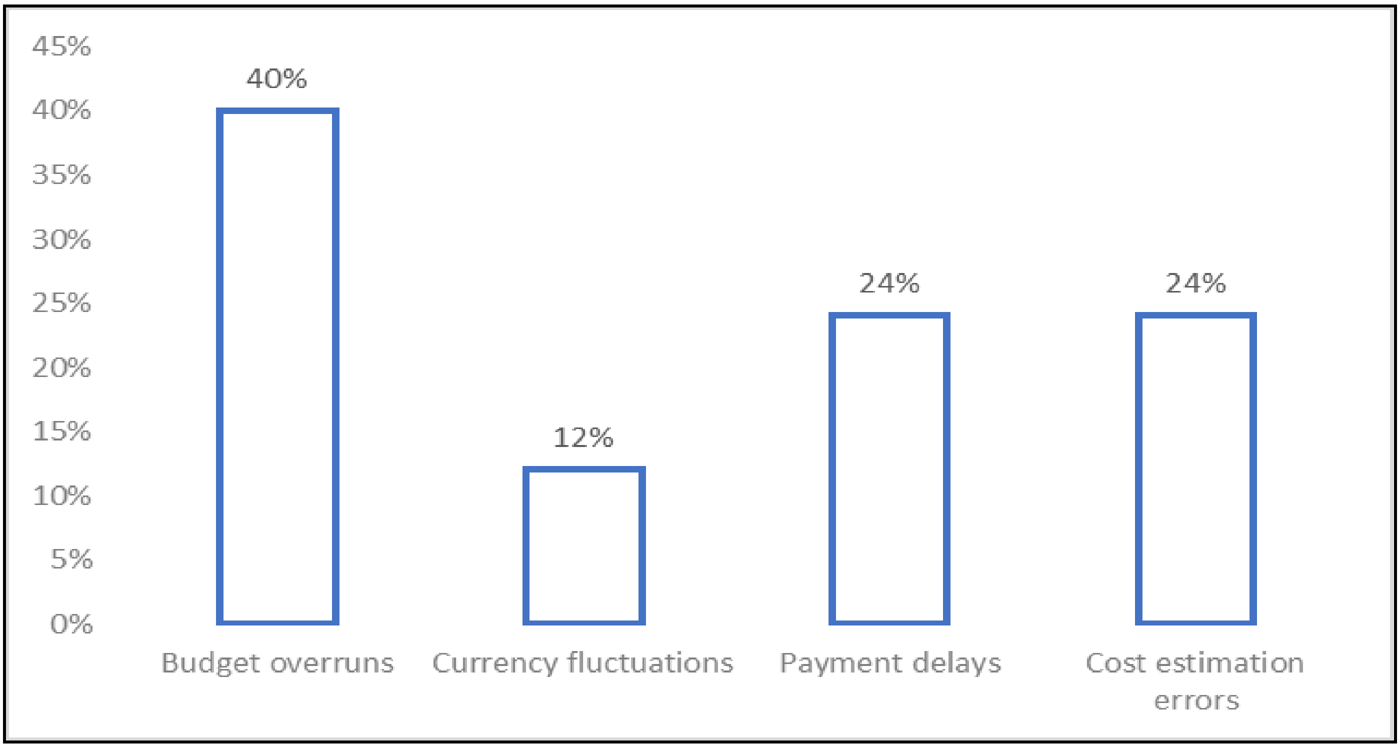

Fig 16 Financial Risk Posing Challenge

Dust pollution (24%) and other environmental risks (24%) are the most likely to occur, followed by soil erosion (20%), while wildlife interference and flooding each account for 16%.

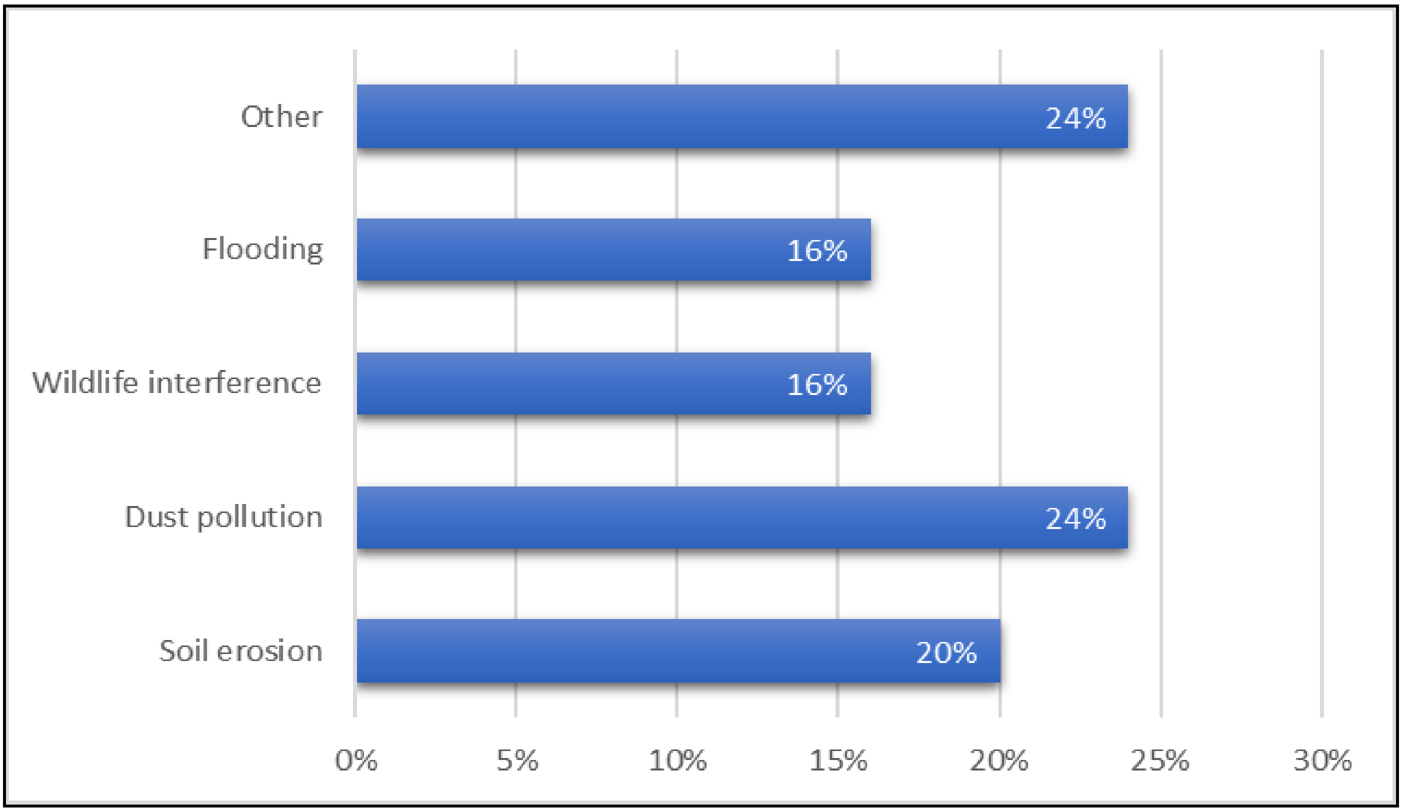

Fig 17 Environmental Risk Most Likely During Implementation

Fiber damage (28%) is the operational risk most affecting project continuity, followed by communication loss (24%), power outages (20%), other risks (16%), and access restrictions (12%). These results indicate that infrastructure integrity and communication systems are critical to uninterrupted project execution.

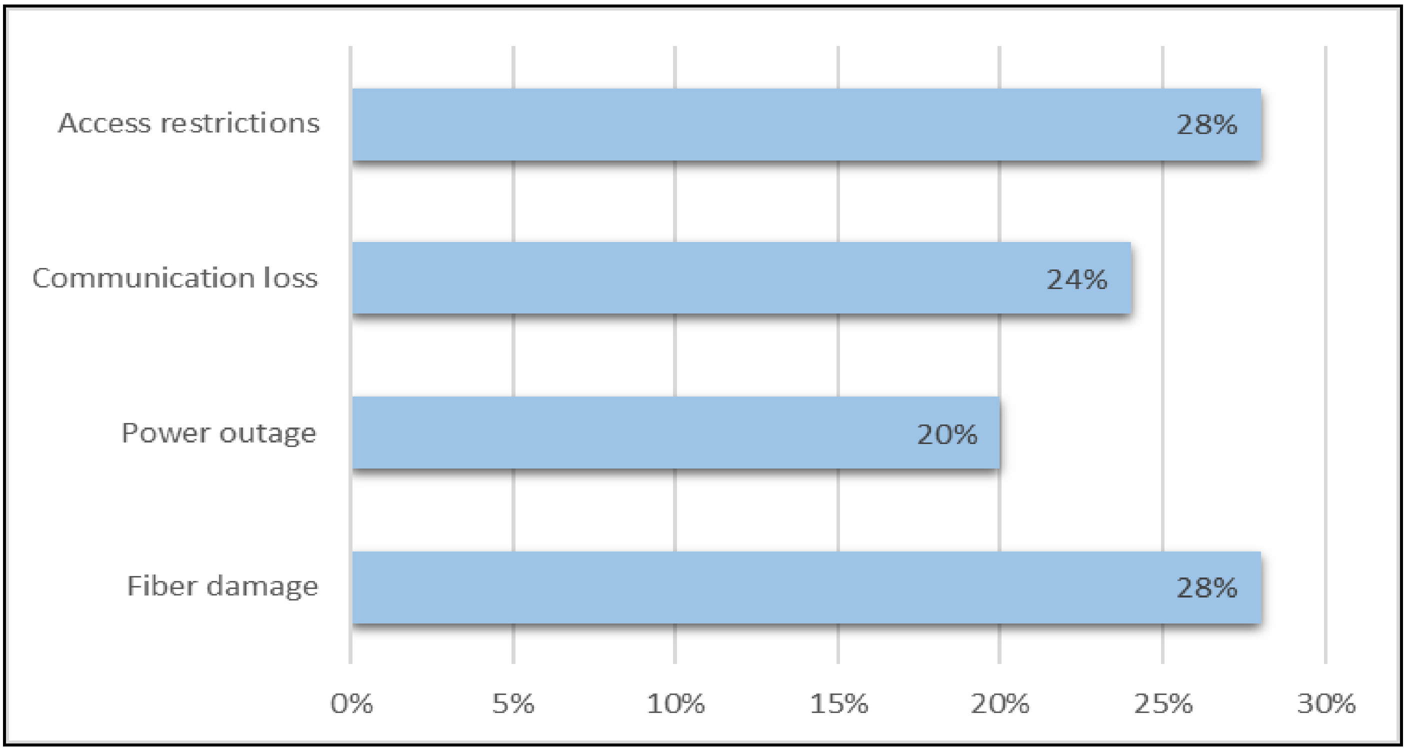

Fig 18 Operational Risk Affecting Project Continuity

Licensing (28%) is the regulatory factor most affecting project progress, followed by local authority approvals (24%), compliance audits (20%), and environmental permits (28%). The findings suggest that obtaining timely regulatory approvals is essential to avoid project delays.

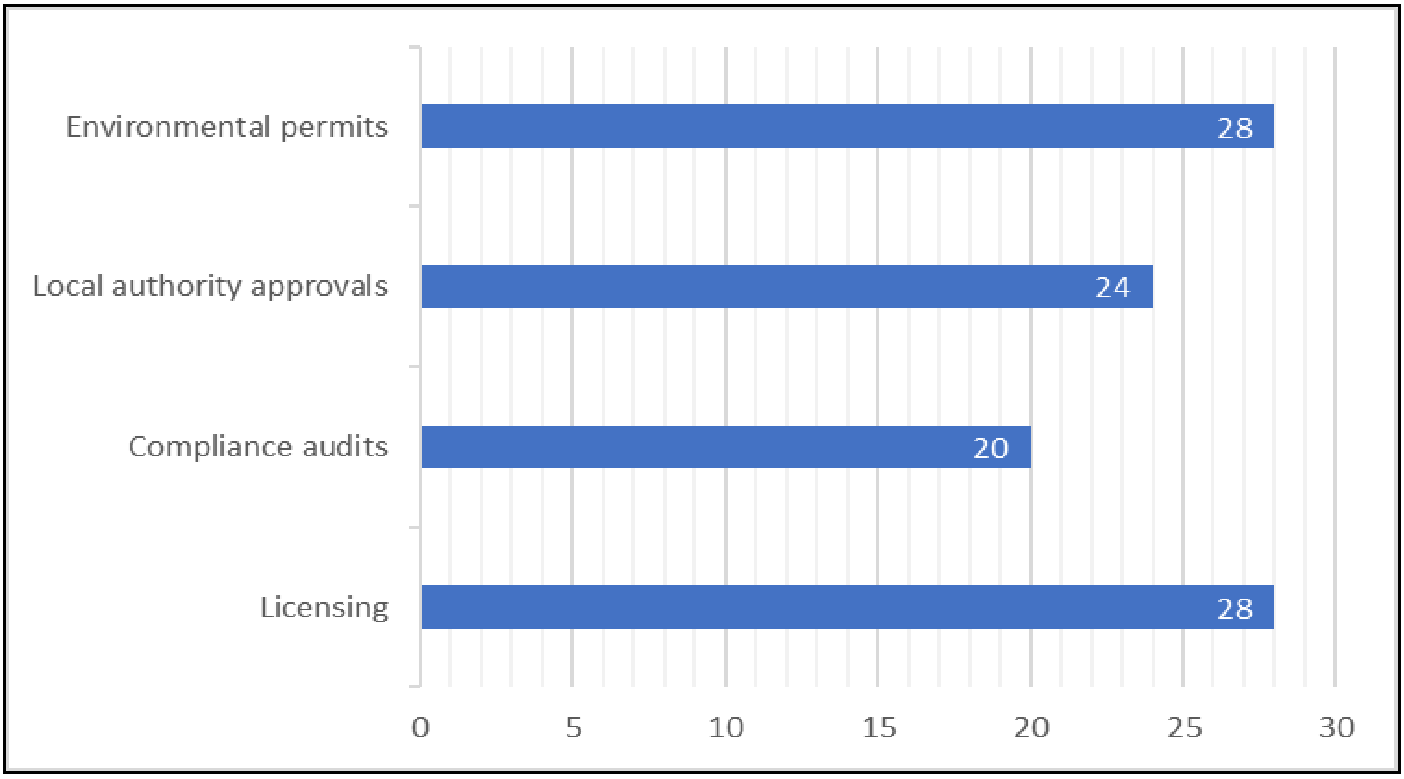

Fig 19 Regulatory Factor Most Affecting Project Progress

Skill shortages (36%) are the predominant human-related risk, followed by miscommunication (24%), absenteeism (16%), and labor disputes (12%). This highlights the importance of workforce capacity planning and effective team communication to maintain project performance.

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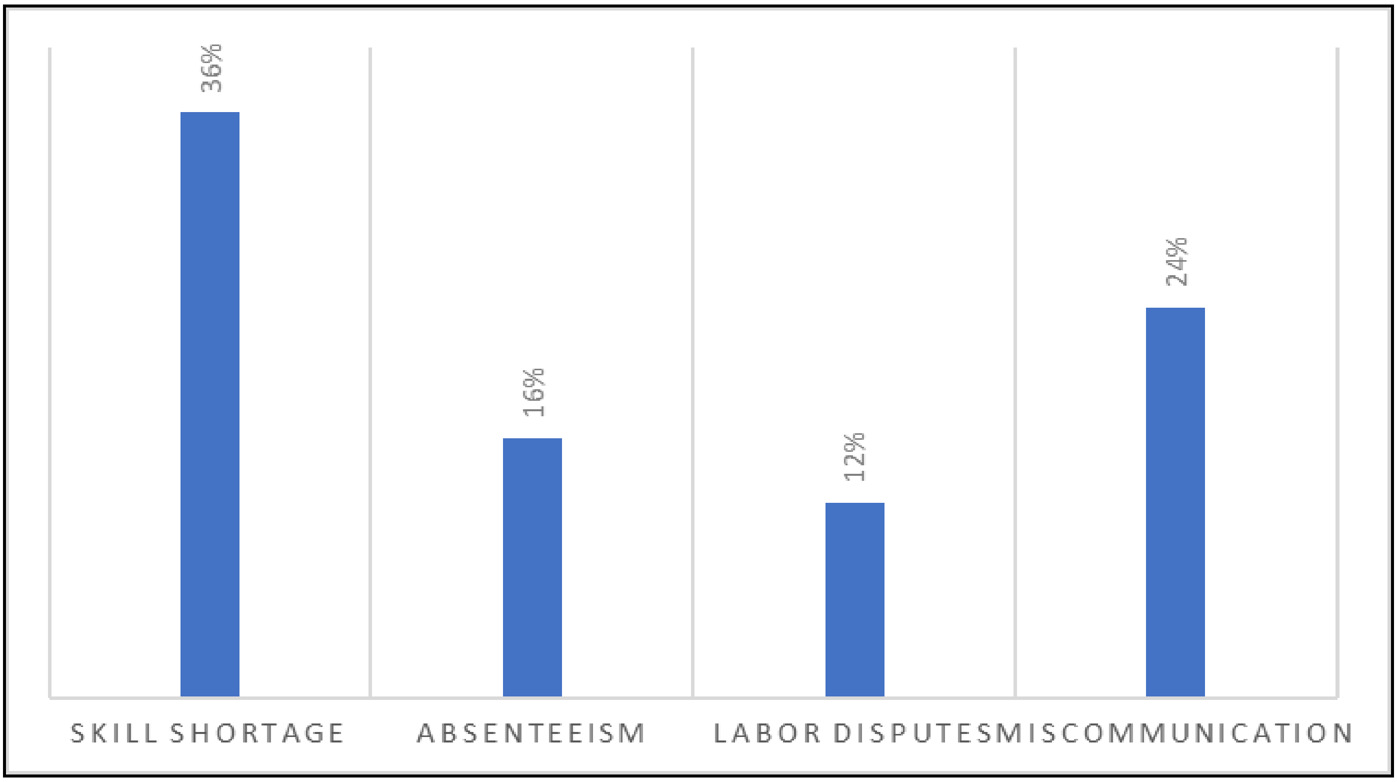

Fig 20 Human-Related Risk Affecting Implementation Most

Poor network testing (28%) is the technological risk that most affects project performance, followed by software failure (20%) and integration issues (20%), with obsolete equipment and other factors at 16% each.

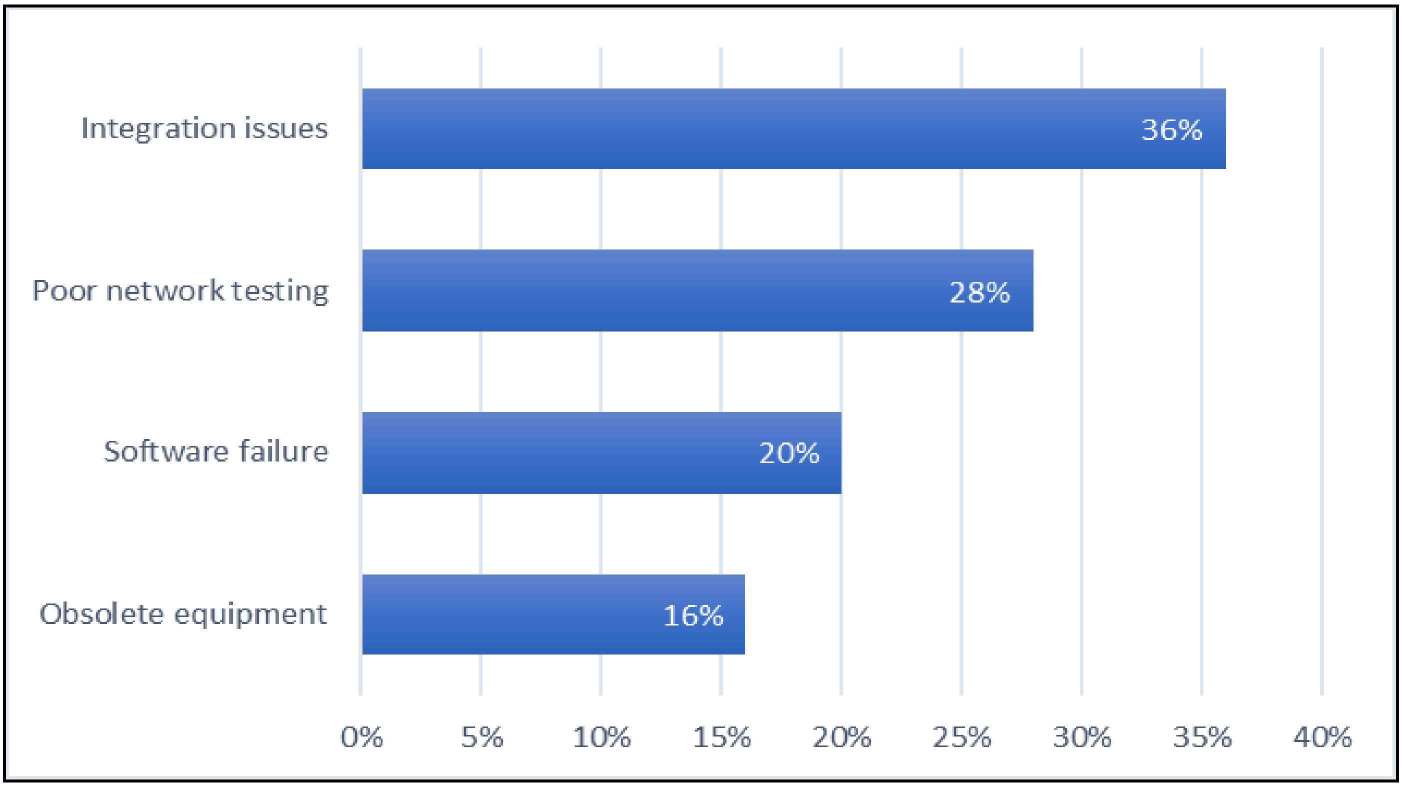

Fig 21 Technological Risk Affecting Project Performance Most

Financial loss (36%) and safety incidents (32%) are identified as the risks with the highest potential to cause a project shutdown, followed by technical failure (20%) and regulatory breach (12%). This indicates that financial management and safety compliance are critical to project survival.

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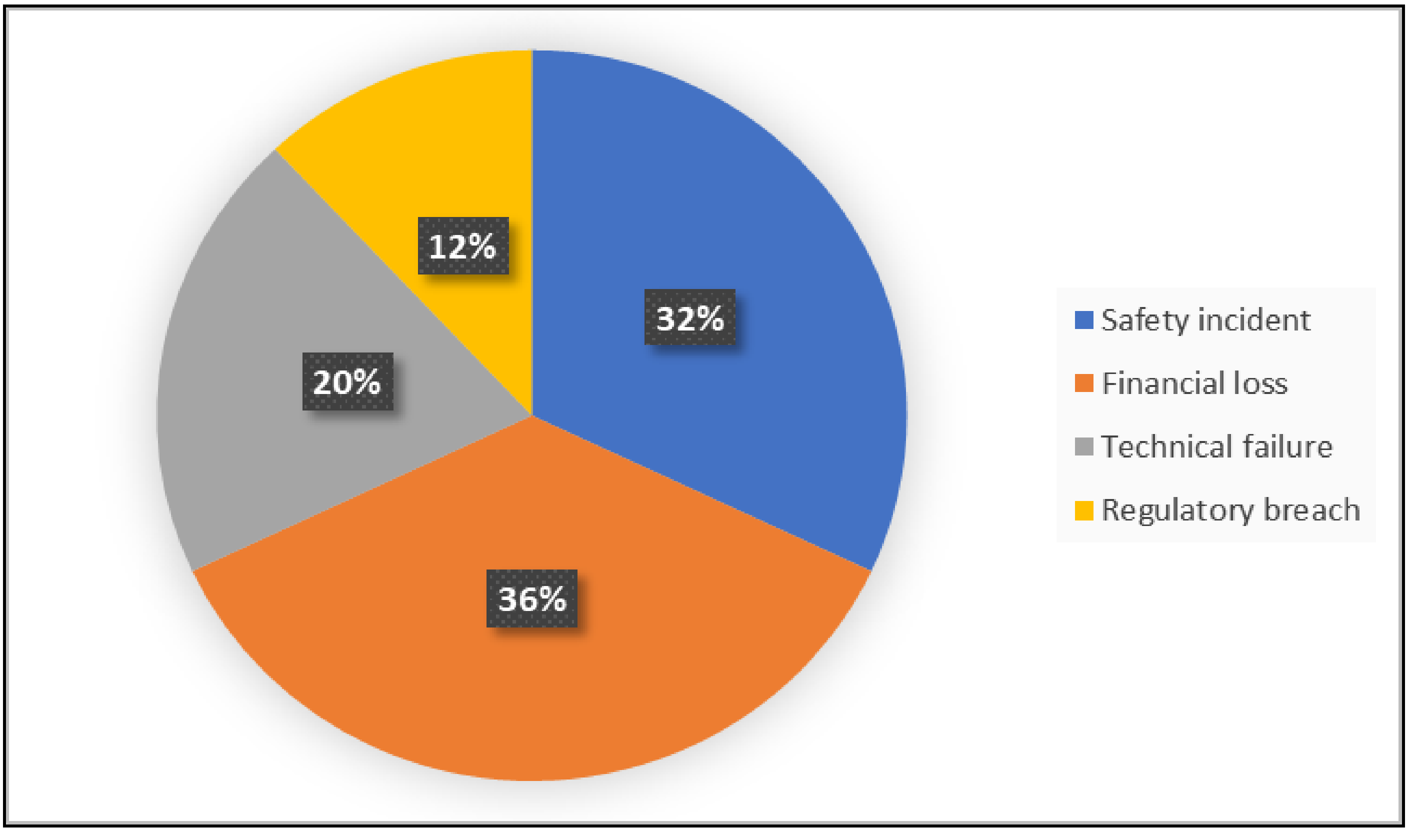

Fig 22 Risk with Highest Potential to Cause Project Shutdown

A chi-square test was used to check whether the rating of technical risks in the project is linked with how often supplier-related delays occur. The Pearson chi-square value was 50.0 with 6 degrees of freedom and a p-value below 0.001, so the data provide evidence of an association between the two variables. The likelihood-ratio test gave a similar result ($p < 0.001$).

Table 2 Chi-Square Test Results Showing Association Between Technical Risks and Supplier-Related Delays

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	50.000[a]	6	.000
Likelihood Ratio	62.069	6	.000
Linear-by-Linear Association	3.063	1	.080
N of Valid Cases	50		

A chi-square test was conducted to examine the relationship between how financial constraints (such as budget overruns or funding delays) are rated in the project and the perceived risk level associated with subcontractor performance. The results showed a significant association between the two variables, with a Pearson Chi-Square value of 51.111, degrees of freedom = 6, and a p-value of .000. This indicates that the way respondents assess financial constraints is closely linked to how they perceive subcontractor risks.

Table 3 Association Between Financial Constraints and Perceived Subcontractor Performance Risk

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	51.111[a]	6	.000
Likelihood Ratio	50.912	6	.000
Linear-by-Linear Association	29.594	1	.000
N of Valid Cases	50		

➢ *Risk Mitigation Strategies*

Expert consultation (28%) and stakeholder workshops (28%) are reported as the most effective methods for identifying project risks, followed by site inspections (24%) and historical data analysis (20%).

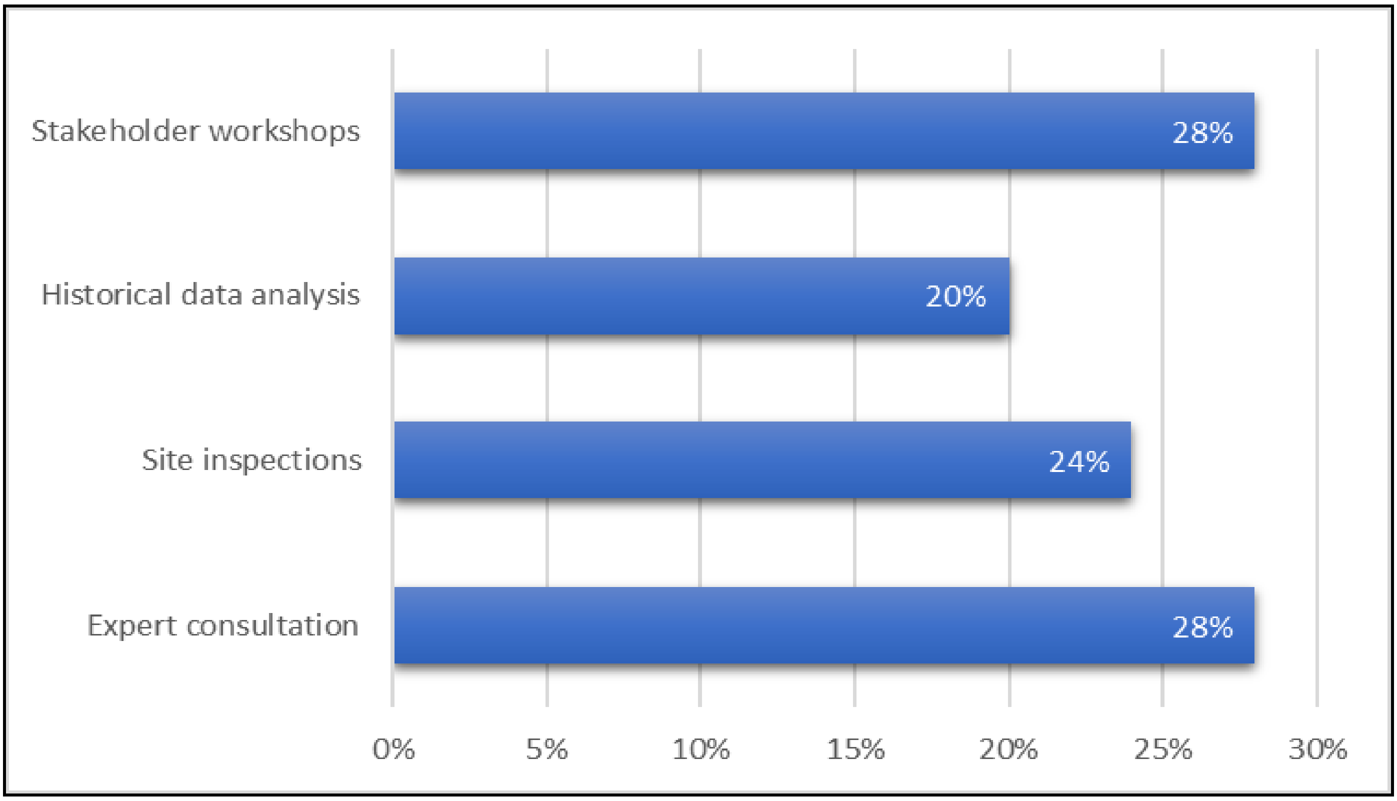

Fig 23 Method Most Effective in Identifying Project Risks

Risks are primarily prioritized based on impact (36%), followed by likelihood (28%), stakeholder input (20%), and cost (16%). This indicates that the project team emphasizes the potential severity of risks over other factors when determining which risks to address first.

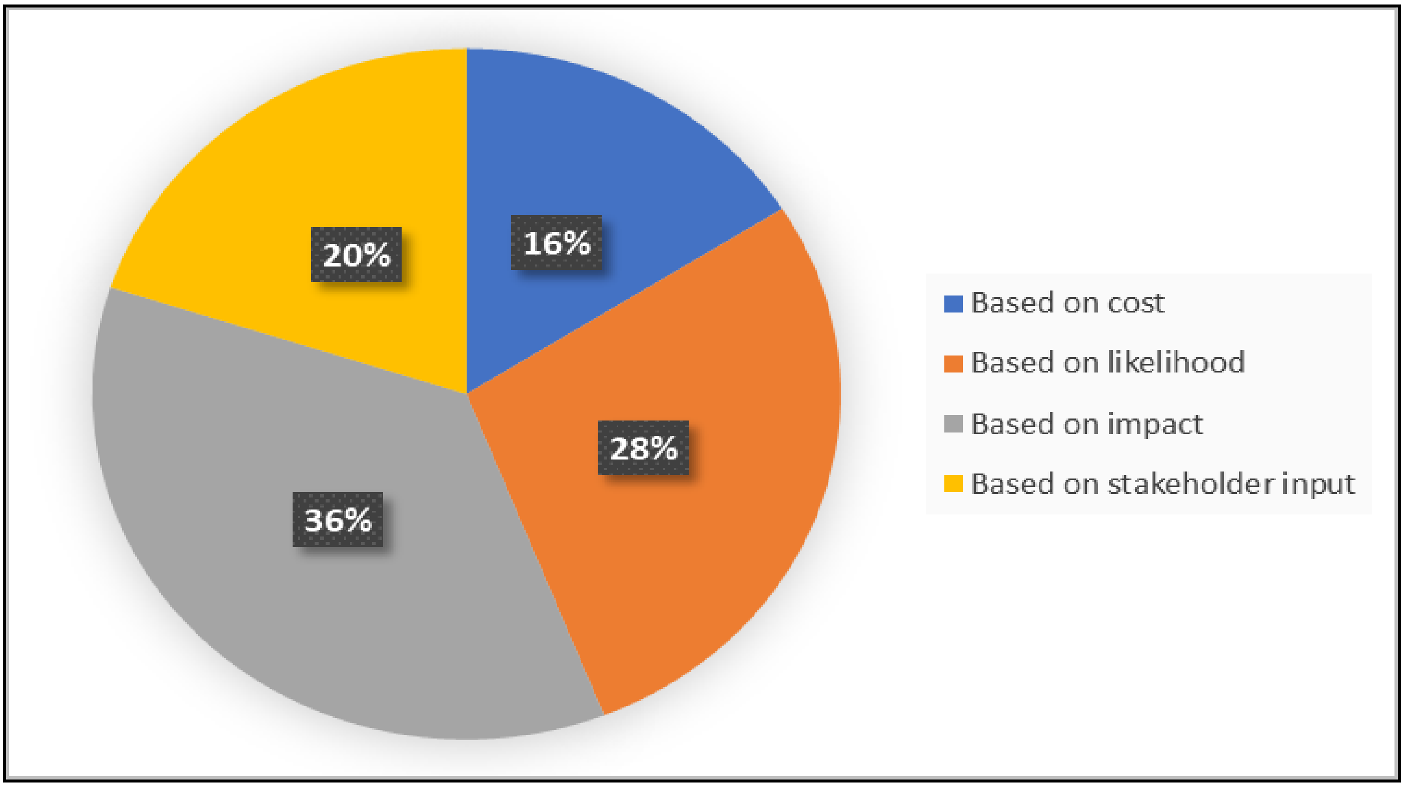

Fig 24 How Identified Risks Are Prioritized for Action

The probability-impact matrix (40%) is the most effective tool for assessing risk impact, followed by the risk register (24%), scenario modeling (24%), and SWOT analysis (12%).

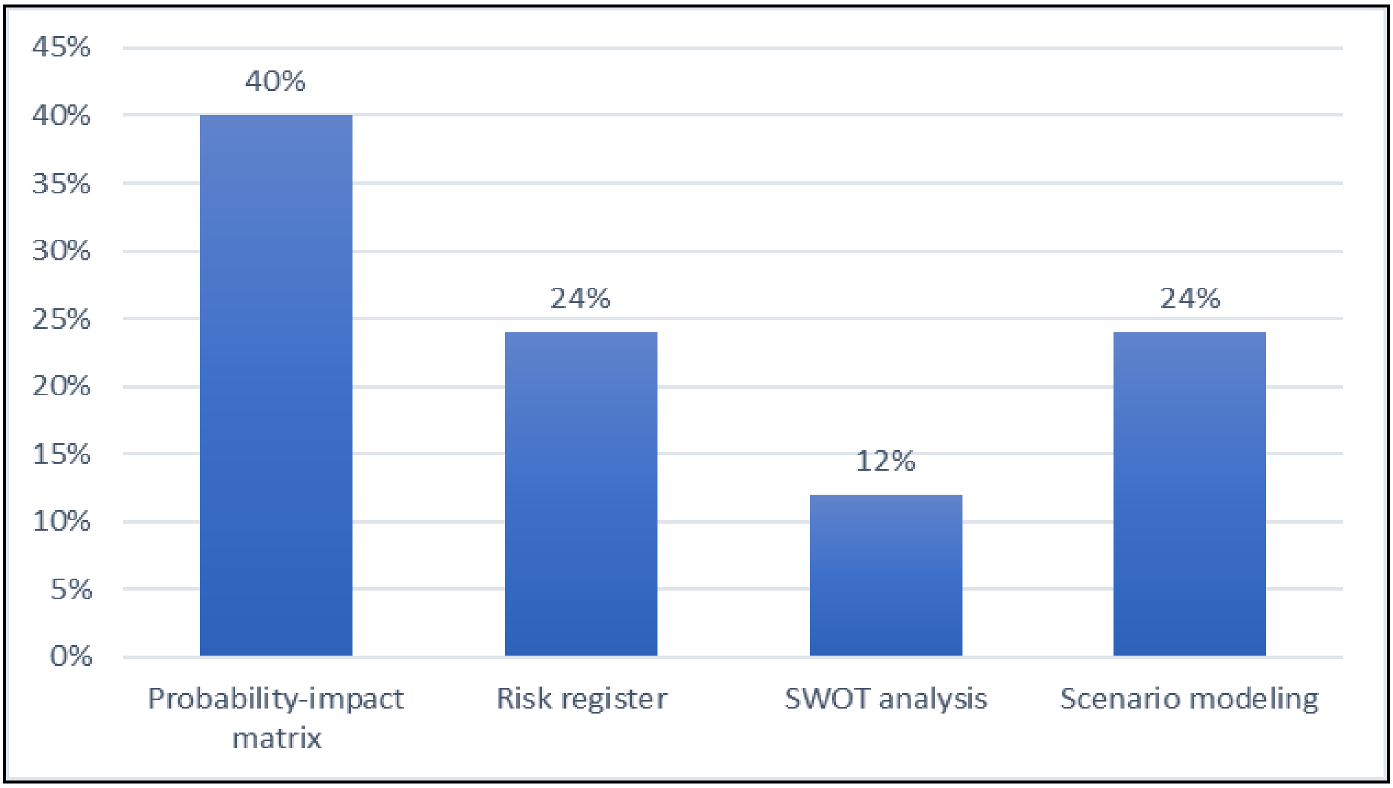

Fig 25 Tool Most Effective for Assessing Risk Impact

Preventive maintenance (32%) is the most commonly applied strategy for mitigating technical risks, followed by process review (24%), redesign (20%), and contractor replacement (16%). This suggests that proactive maintenance and process improvements are preferred over reactive solutions.

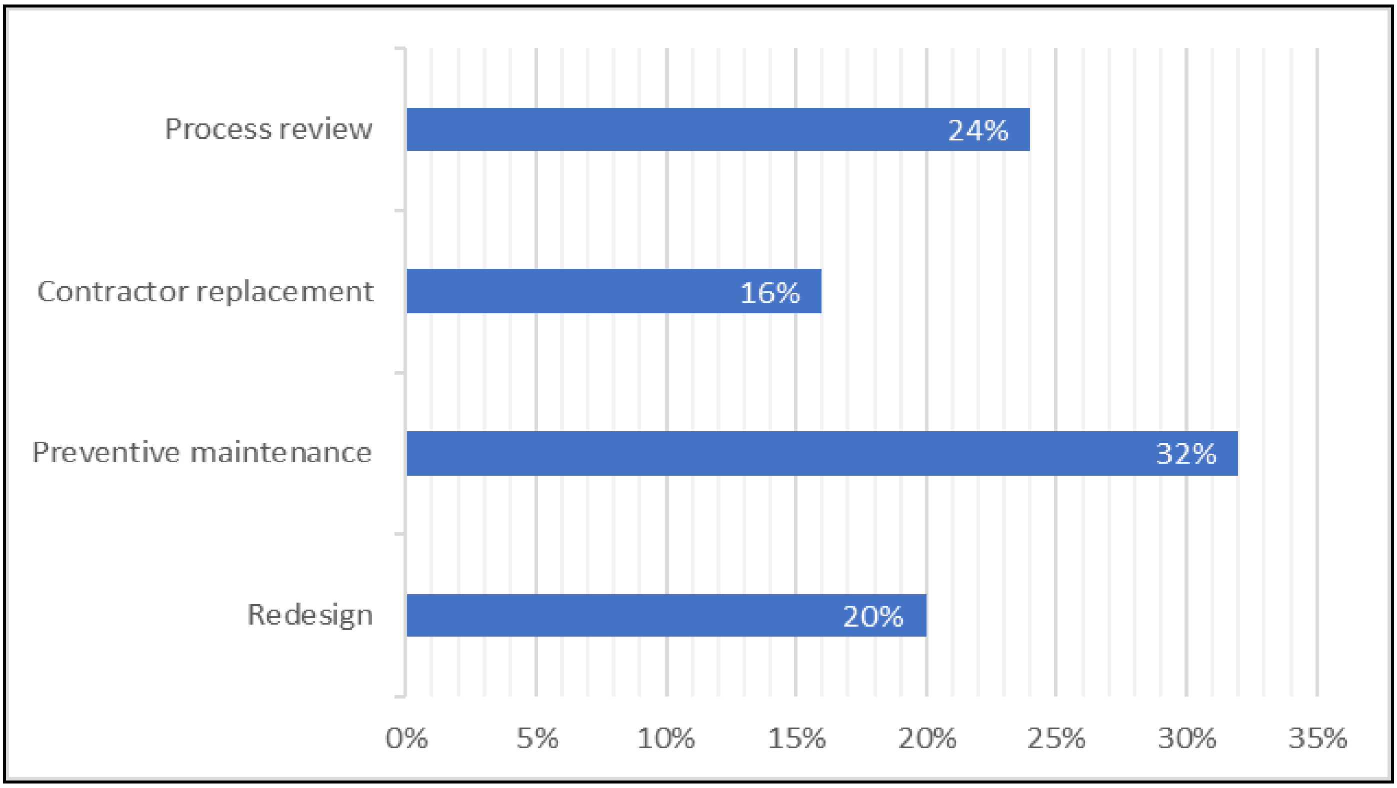

Fig 26 Strategy Most Often Applied for Mitigating Technical Risks

Budget reserves (36%) are the primary approach for managing financial risks, followed by contract renegotiation (28%), cost tracking (24%), and insurance (12%).

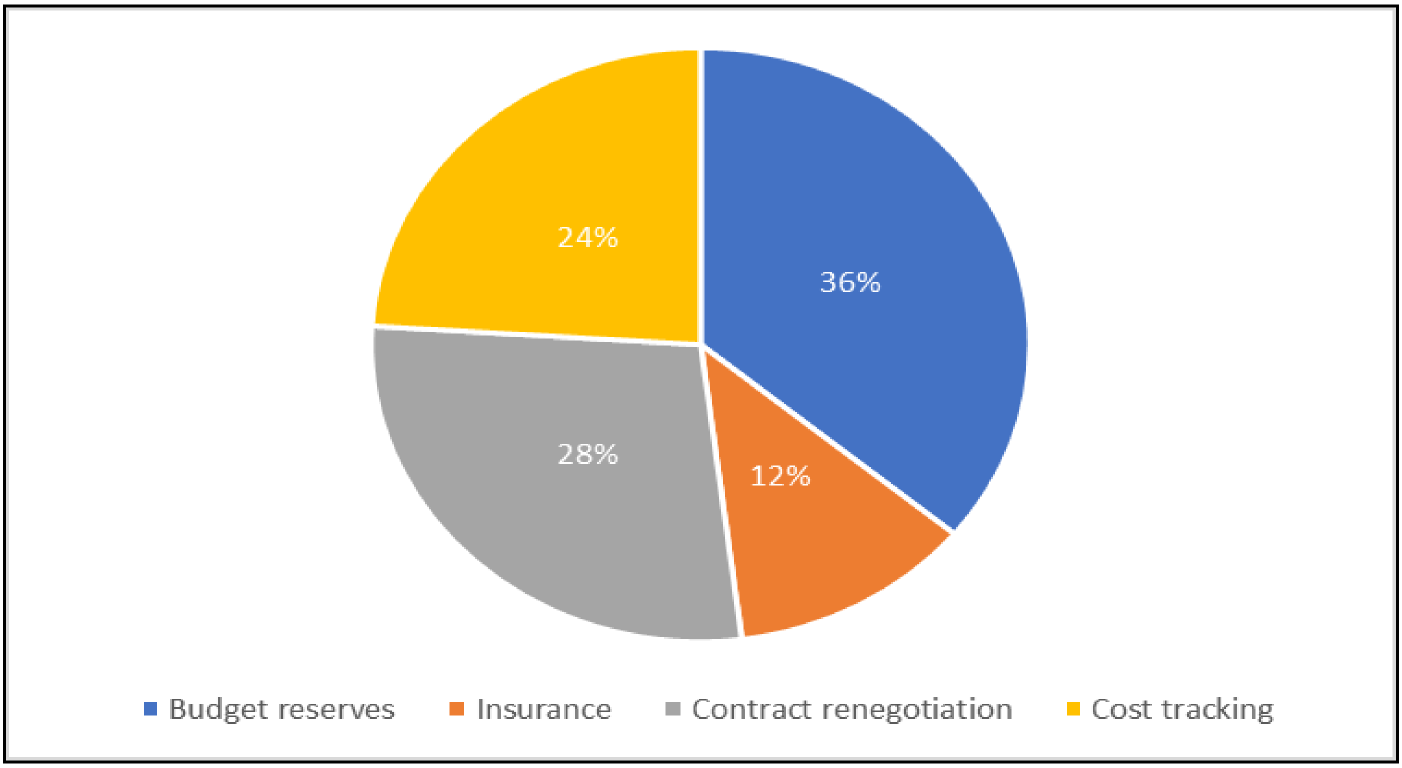

Fig 27 Approach Most Successful in Managing Financial Risks

Mitigation plans are monitored primarily through reports (32%) and on-site reviews (28%), with audits (20%) and software tools (20%) being less frequent.

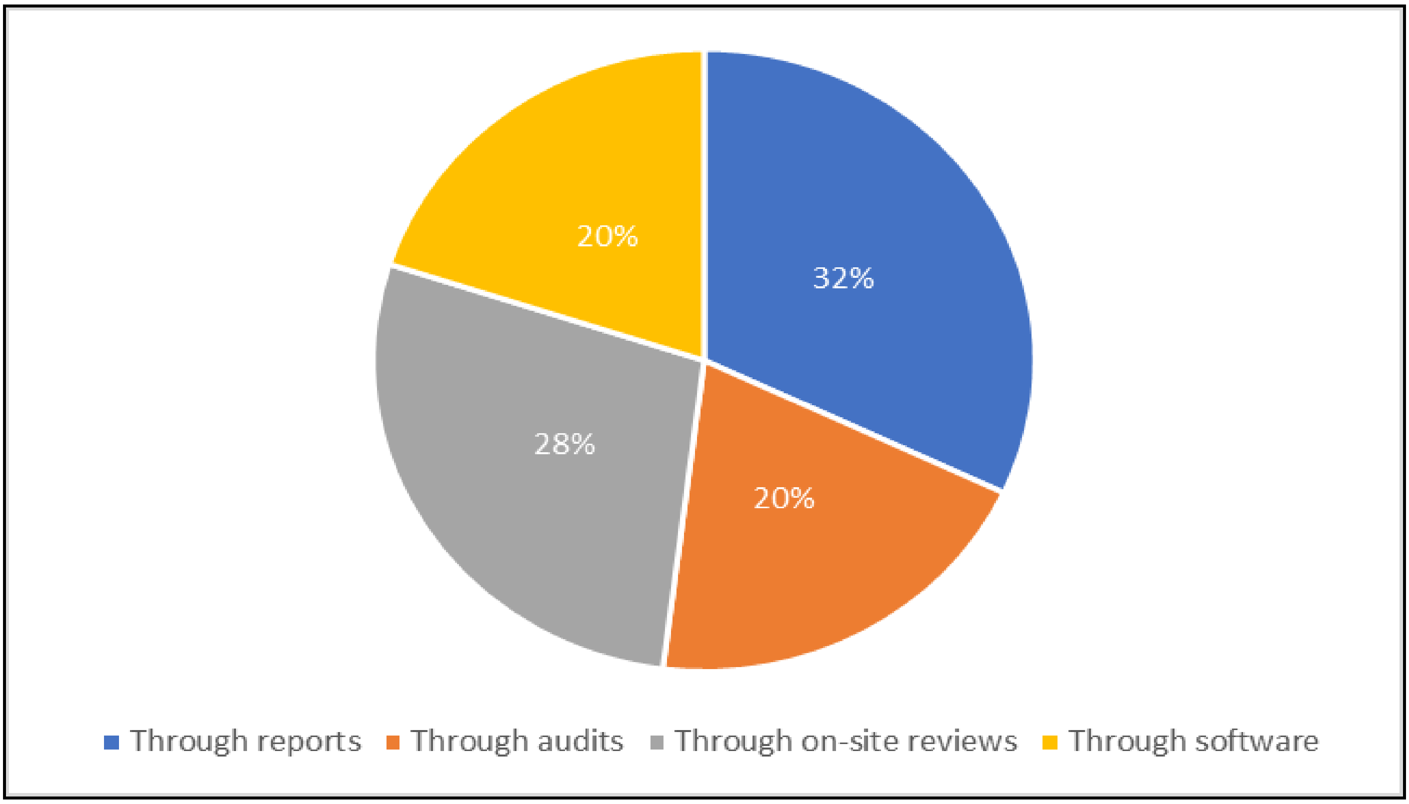

Fig 28 How Mitigation Plans Are Monitored for Progress

Incident alerts (32%) and dashboard updates (28%) are the most effective communication approaches for improving risk response, followed by weekly review meetings (24%) and memos (16%).

ISSN No: -2456-2165 https://doi.org/10.38124/ijisrt/26jan635

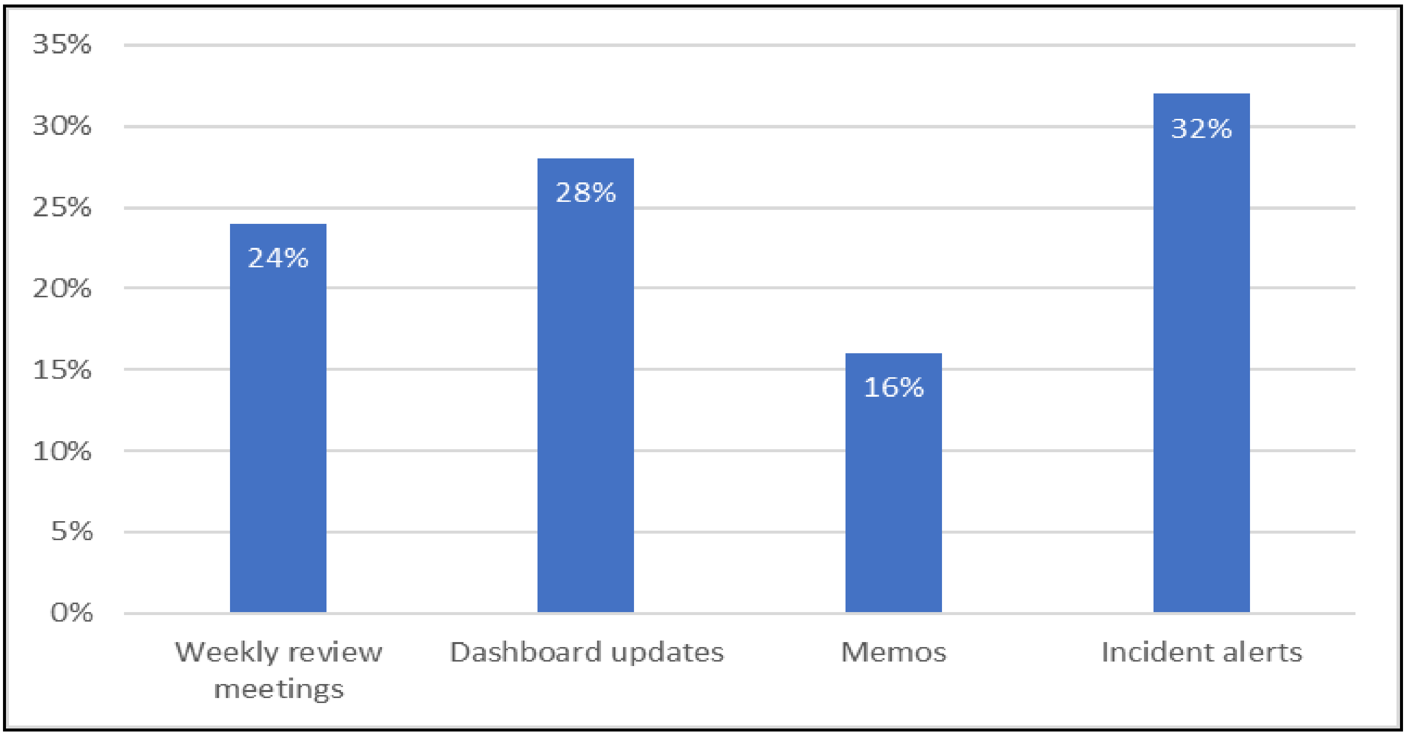

Fig 29 Communication Approach That Has Improved Risk Response

Assigned ownership (44%) is the primary mechanism ensuring accountability, followed by team reviews (20%), documentation tracking (20%), and departmental control (16%). This highlights the importance of clearly defining responsibility for each risk mitigation task.

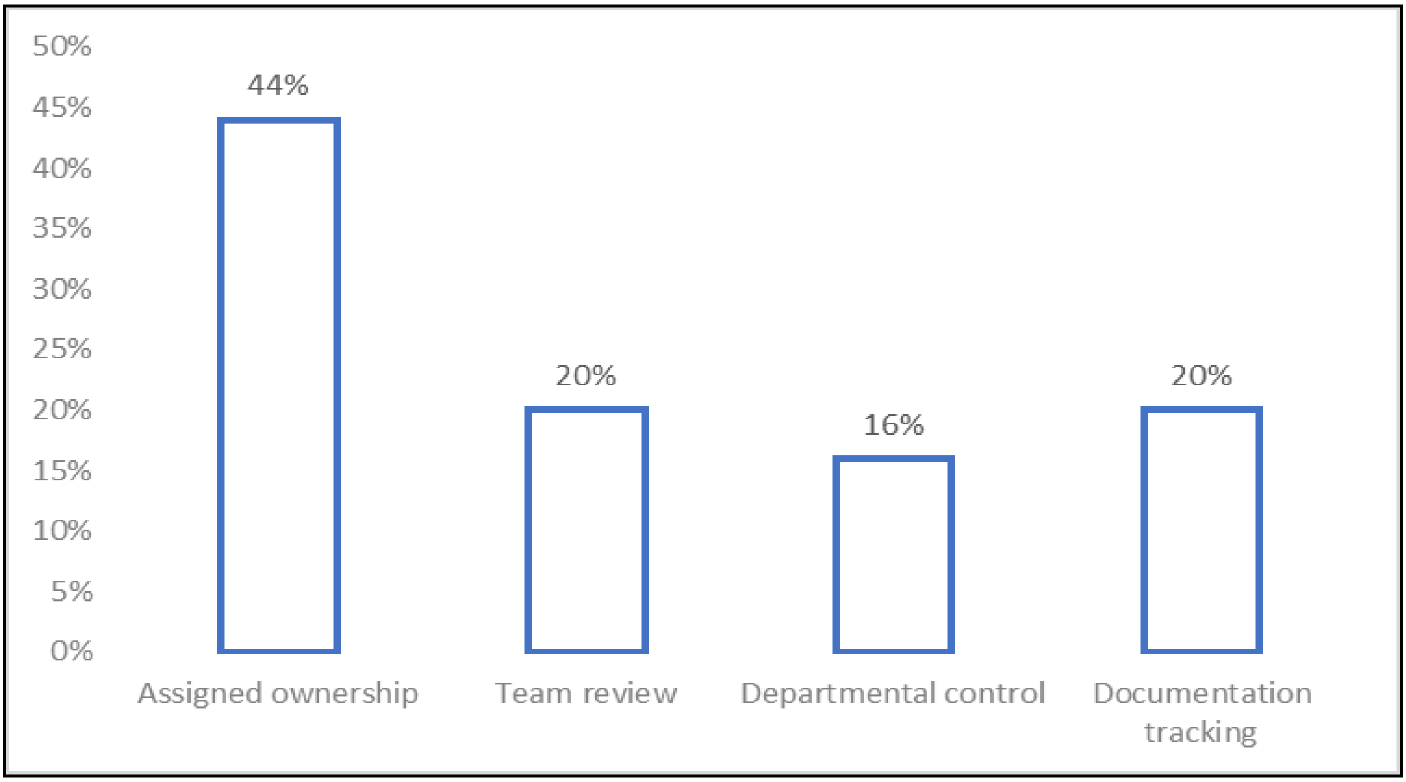

Fig 30 Mechanism That Ensures Accountability in Risk Response

The majority of respondents (40%) report that lessons from past risks are not captured, while workshops (24%), post-project reports (20%), and databases (16%) are used by a minority. This indicates a significant gap in institutional learning and knowledge management for risk management practices.

ISSN No: -2456-2165 https://doi.org/10.38124/ijisrt/26jan635

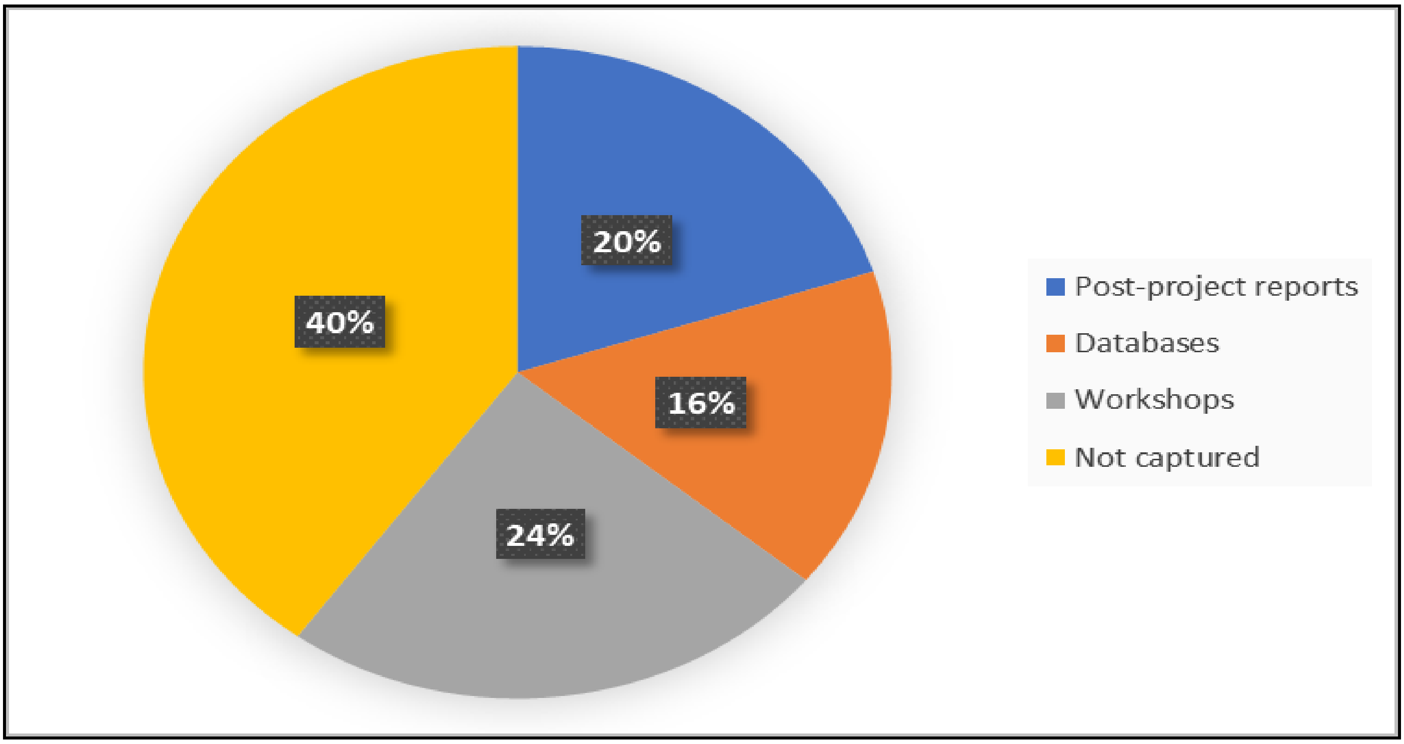

Fig 31 How Lessons from Past Risks Are Captured and Reused

Contingency planning (36%) is identified as the mitigation strategy most effective in reducing project disruptions, followed by early detection (32%) and staff training (28%), with vendor monitoring (4%) being least effective.

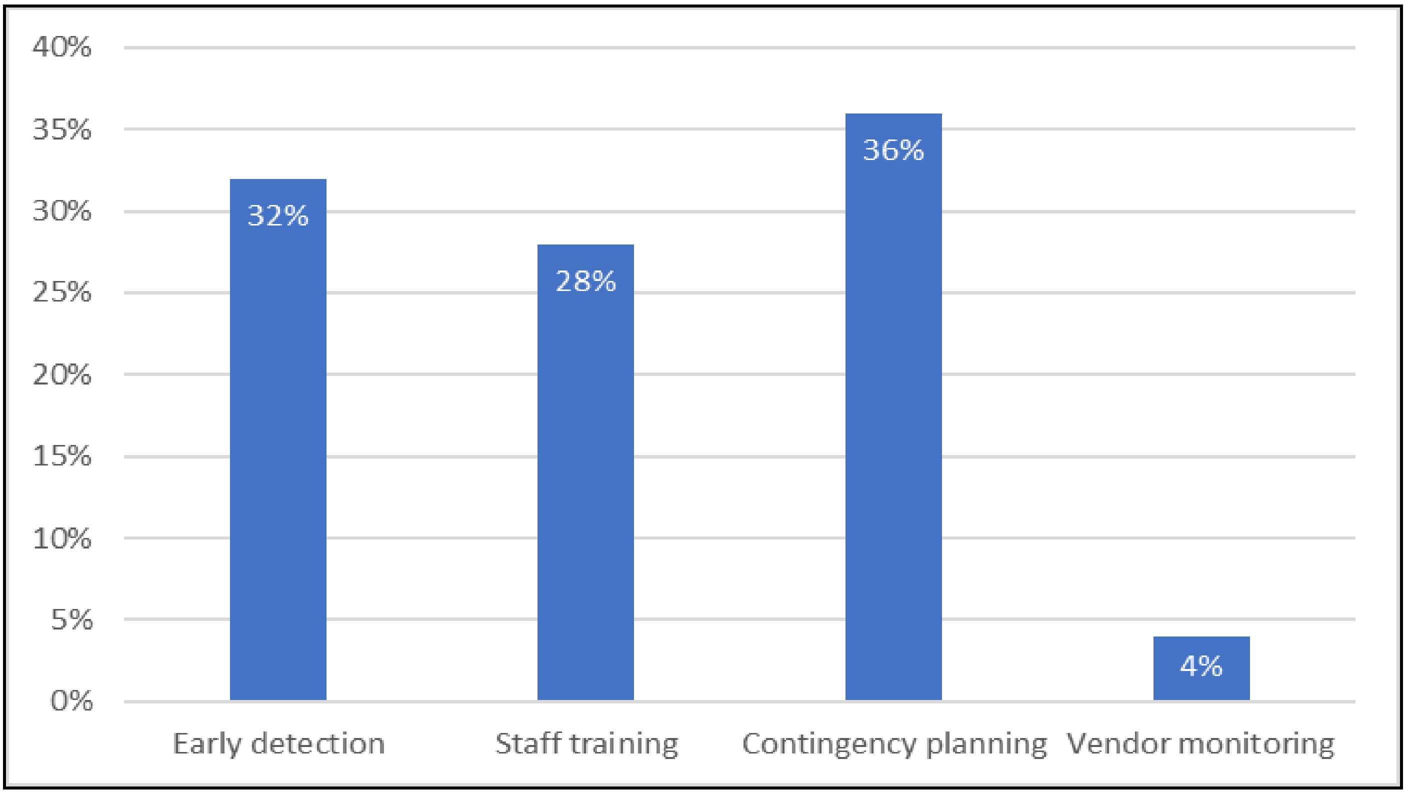

Fig 32 Mitigation Strategy That Has Reduced Project Disruptions Most

➢ *Challenges in Implementing Effective Risk Management Processes*

The primary obstacle is limited expertise (32%), followed by time constraints (28%), lack of tools (20%), and low management support (20%).

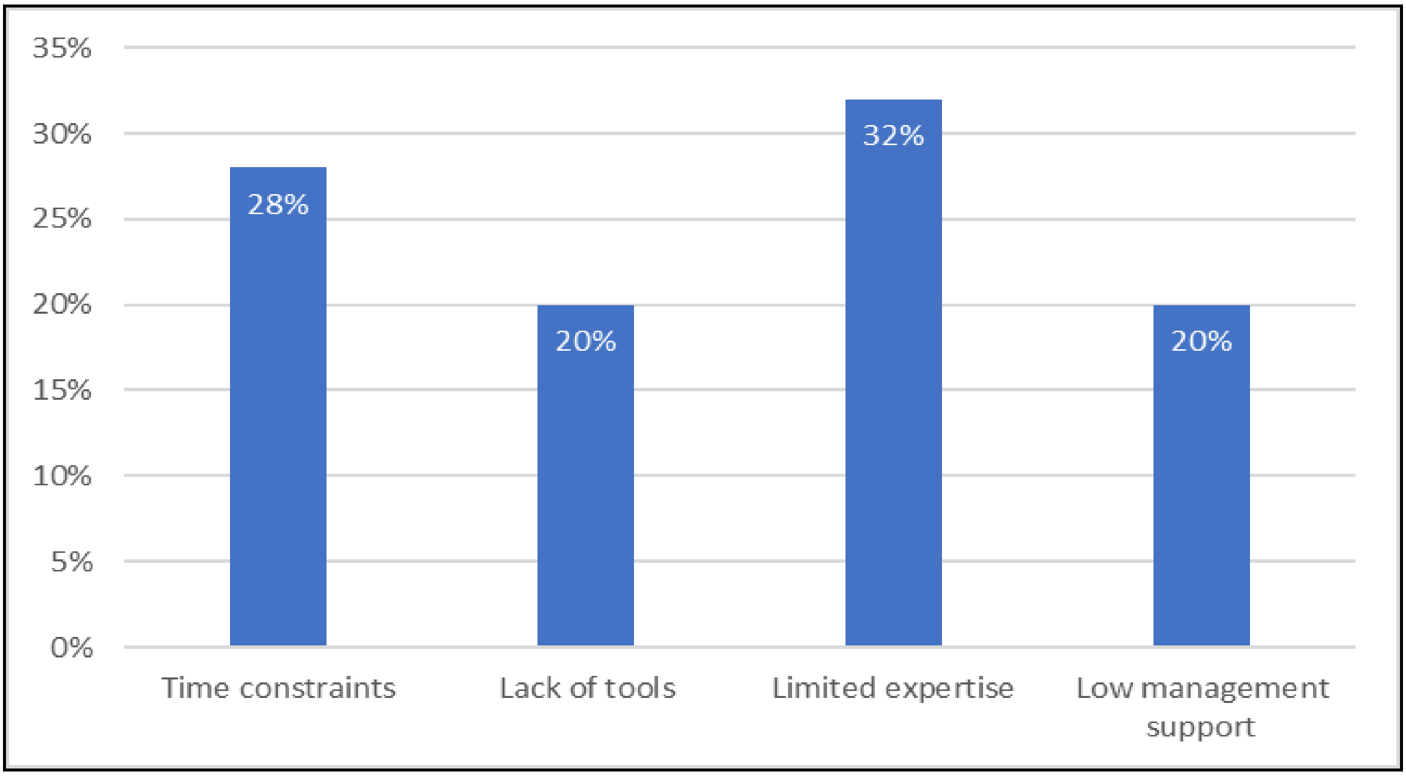

Fig 33 Main Obstacle to Consistent Risk Assessment

Lack of training (40%) is the most significant factor limiting staff participation, followed by heavy workload (24%), poor communication (20%), and no incentives (16%).

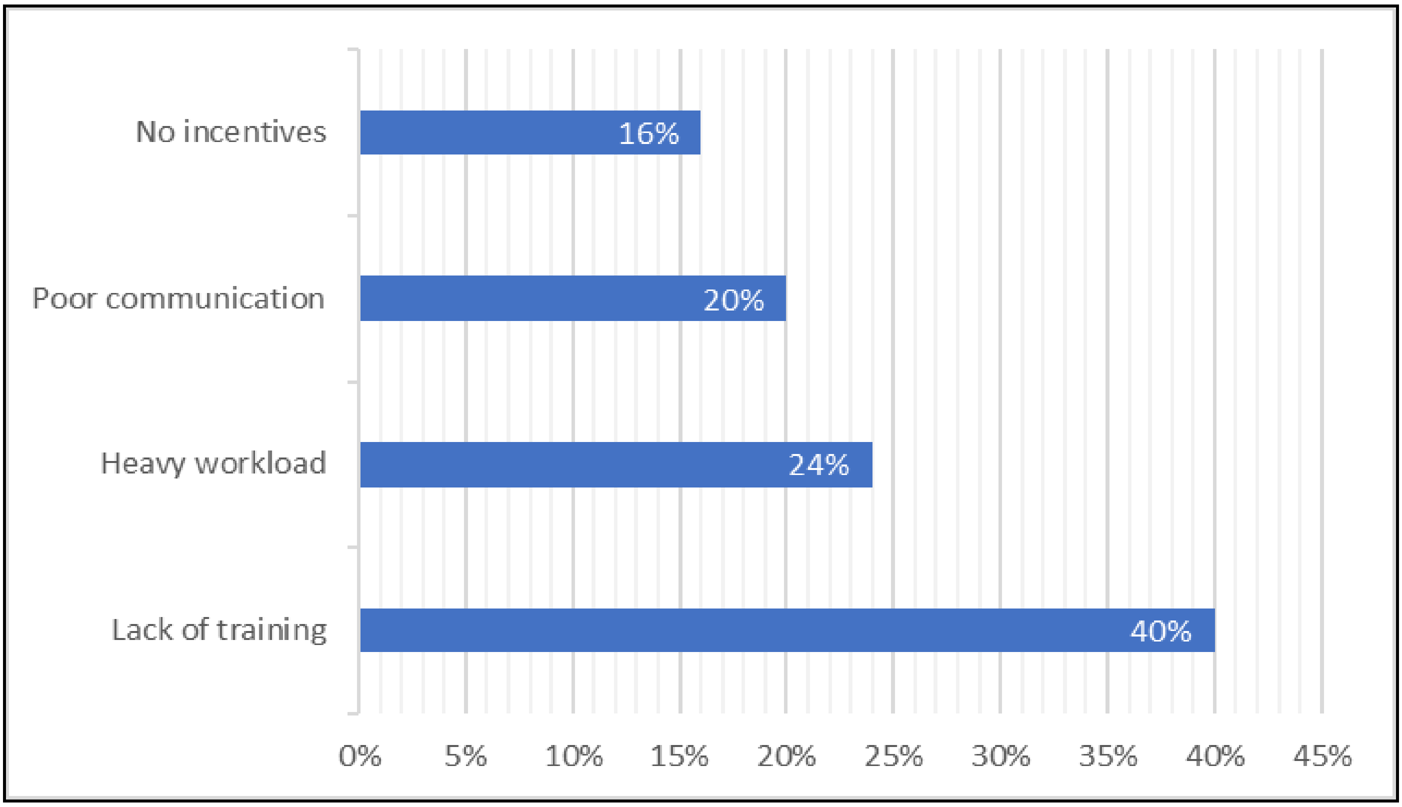

Fig 34 Factor Limiting Staff Participation in Risk Management

Delayed reporting (32%) is the main challenge, followed by inconsistent formats (28%), incomplete data (24%), and lack of standard forms (16%). This reflects gaps in timely and standardized risk documentation practices, which may hinder accurate risk tracking.

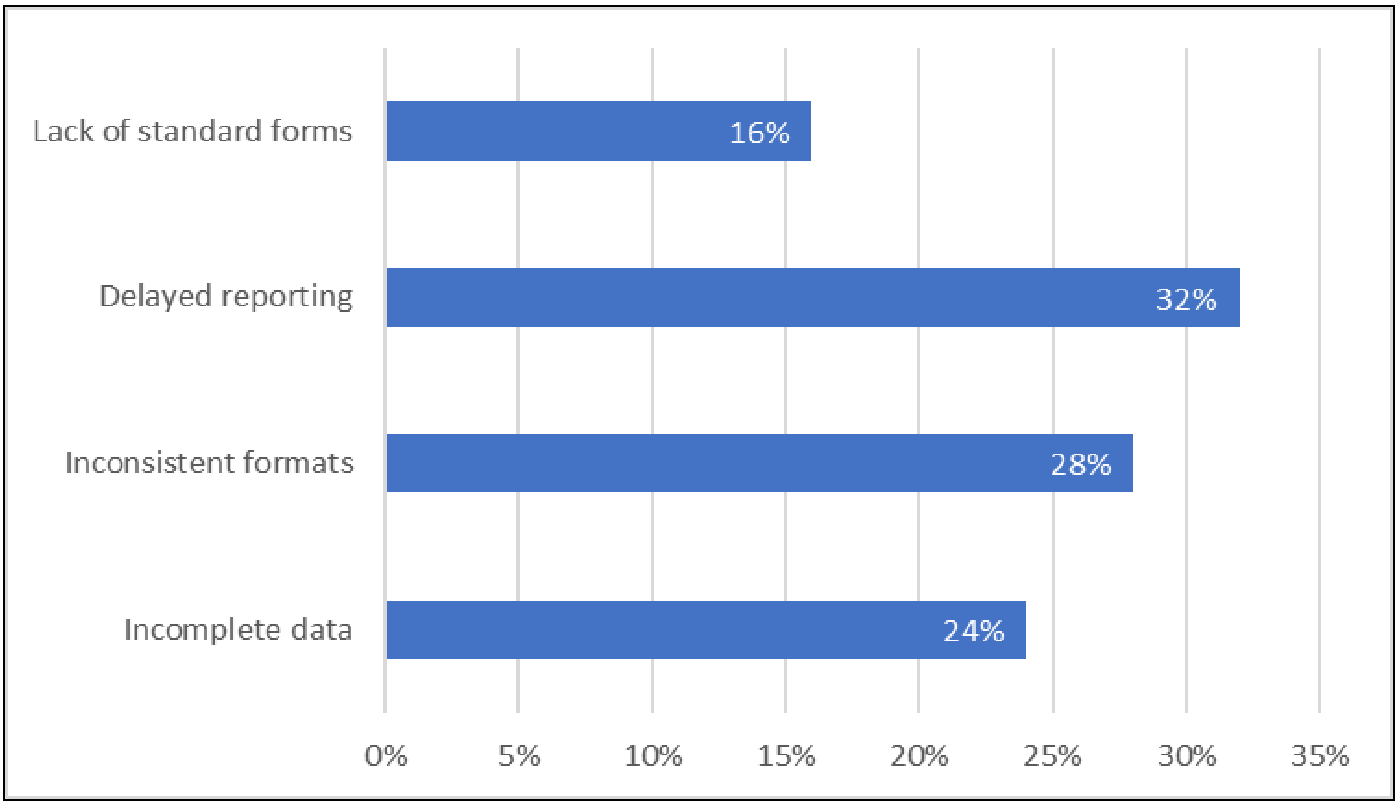

Fig 35 Challenge Arising Most When Documenting Project Risks

Budget limits (36%) are the most cited barrier, followed by poor coordination (24%), delayed approvals (20%), and staff turnover (20%). Financial constraints and organizational coordination challenges are key factors impeding the execution of mitigation strategies.

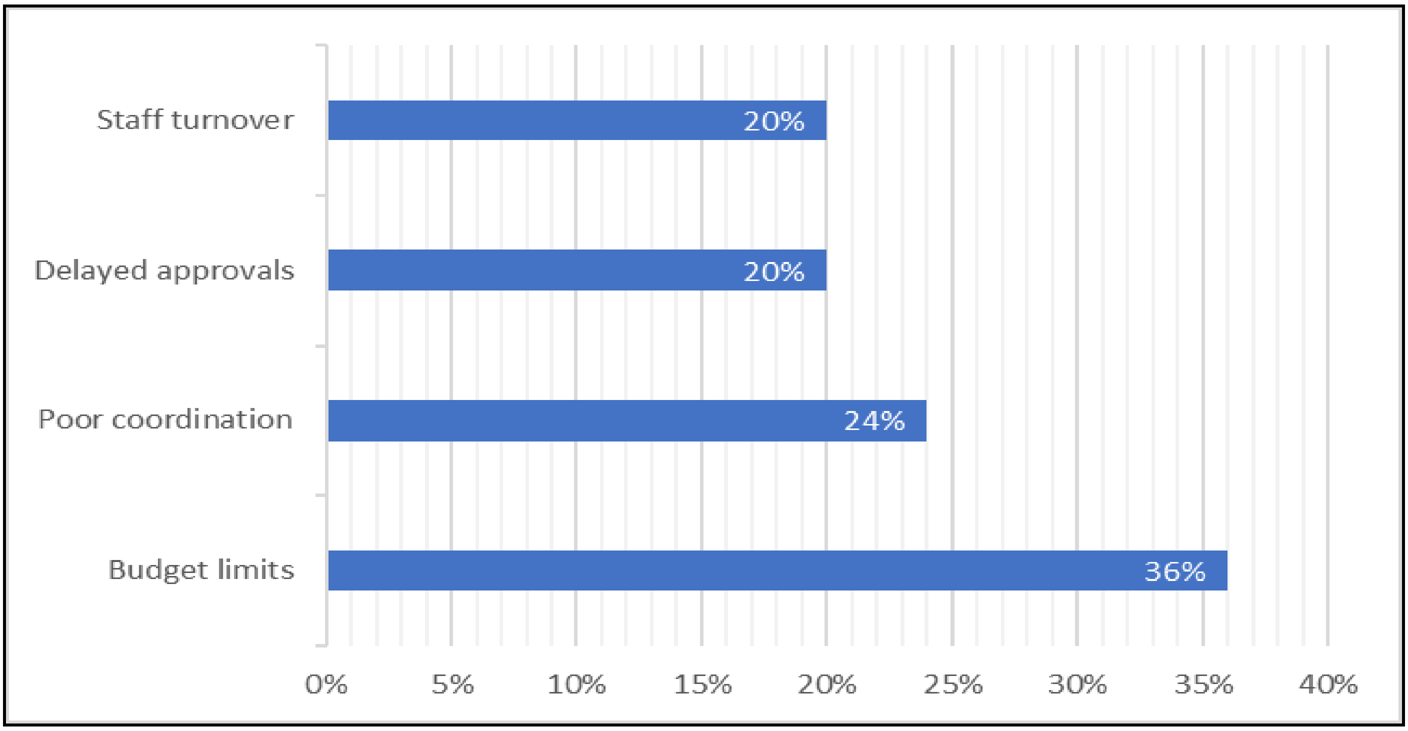

Fig 36 Barrier Affecting Enforcement of Risk Mitigation Plans

Infrequent meetings (28%) and data access issues (24%) are the main barriers, with hierarchical reporting (20%) and language barriers (12%) also affecting communication. This highlights gaps in structured communication channels that limit effective information sharing.

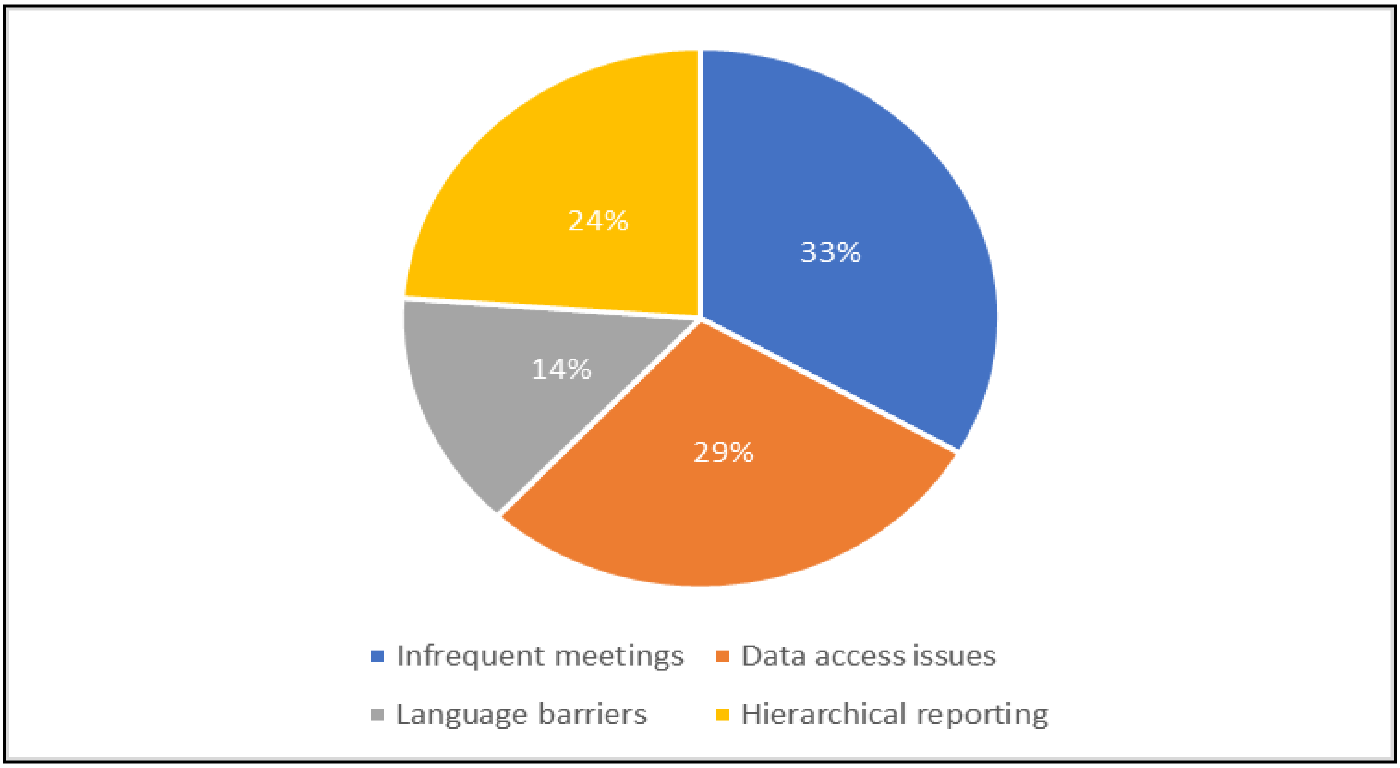

Fig 37 Issue Affecting Communication of Risks Between Teams

Lack of training (28%) and resistance to change (28%) are the leading limitations, followed by cost (24%) and internet instability (20%). These results indicate that both skill deficits and organizational culture hinder the adoption of digital risk management solutions.

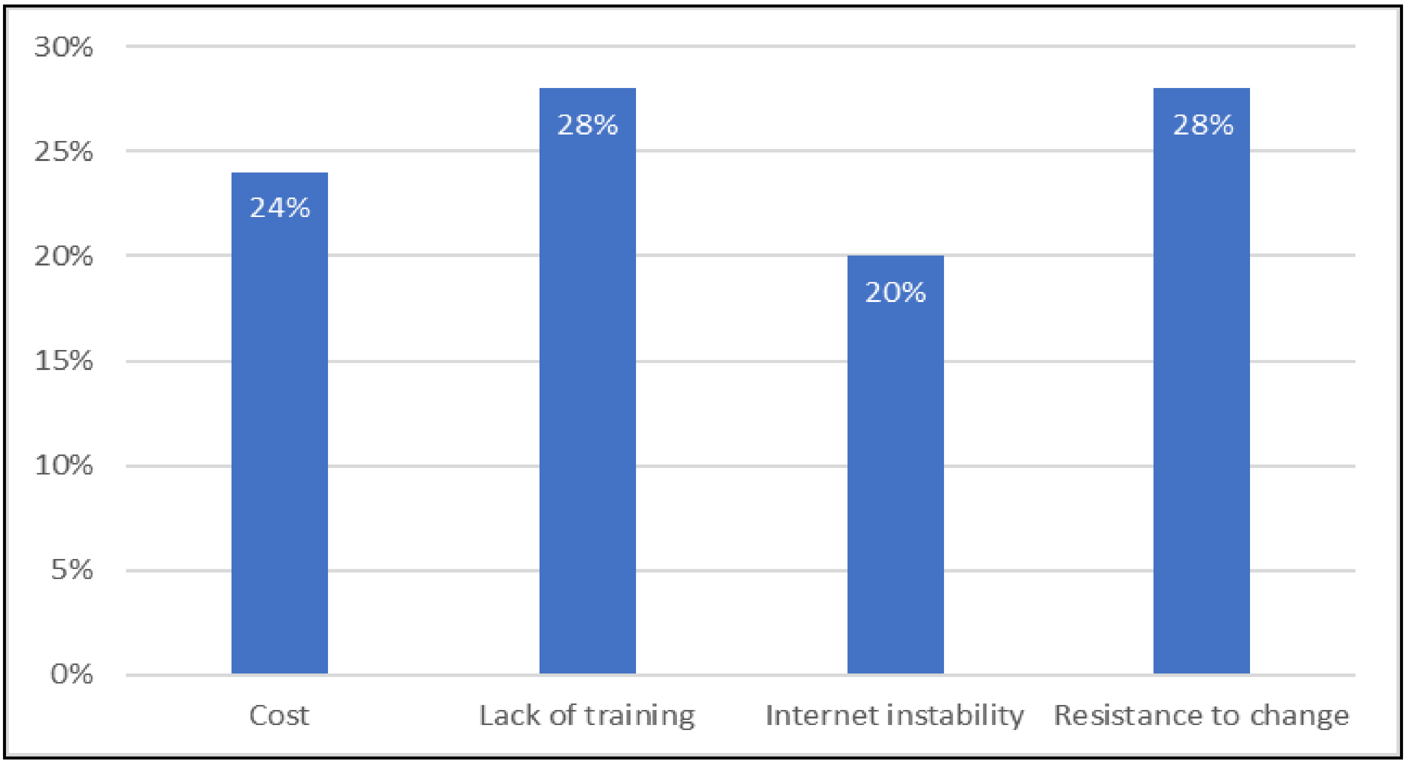

Fig 38 Factors Limiting Use of Digital Tools for Risk Management

Bureaucracy (32%) is the primary cause, followed by limited personnel (24%), poor supervision (24%), and shortage of materials (20%). This suggests that organizational procedures and resource limitations contribute significantly to slow corrective actions.

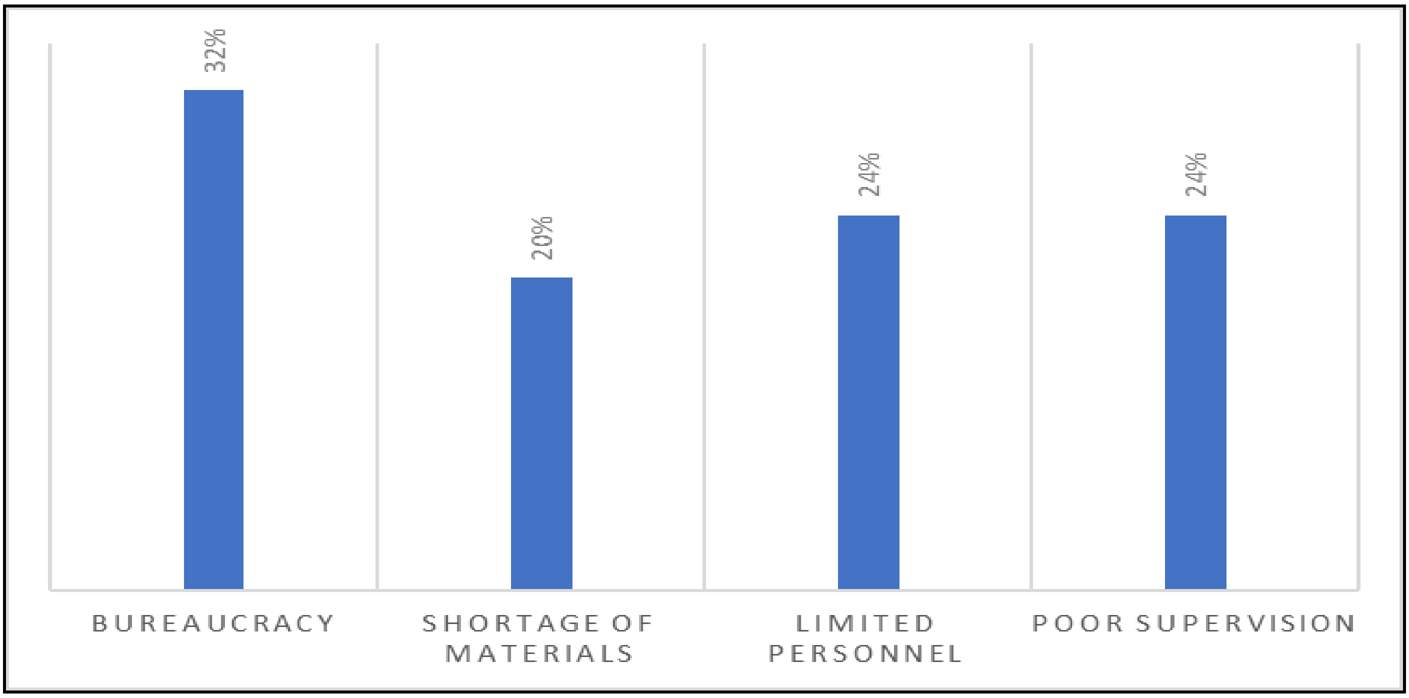

Fig 39 Causes of Delays in Implementing Corrective Measures

V. DISCUSSION

The findings show that risk management in the Lumwana Mine fiber optic project is mainly coordinated by the Project Management Department, supported by engineering, IT, and procurement teams, but collaboration across departments is limited. Formal tools such as risk registers and structured documentation are widely used, though reliance on spreadsheets and meetings indicates partial digitization and delayed communication. Risk identification relies on formal registers, expert input, and brainstorming, while assessment focuses on impact using tools like probability-impact matrices. Technical risks are the most prominent, driven by installation challenges, supply delays, and underground design constraints, while operational, financial, safety, environmental, regulatory, human, and technological risks also affect project performance. Statistical tests show strong links between technical issues and supplier delays, and between financial constraints and subcontractor performance. Mitigation strategies include preventive maintenance, budget reserves, flexible scheduling, safety training, regulatory engagement, and environmental management. However, the project faces challenges such as reactive risk management, inconsistent role assignment, irregular documentation, skill shortages, and reliance on manual systems, indicating a need for integrated digital tools, clearer governance structures, and cross-functional coordination to strengthen overall risk management effectiveness.

VI. CONCLUSION

The assessment shows that the Lumwana Mine Fiber Optic Project follows a structured process for identifying, analyzing, and responding to risks. Risk assessments are carried out at project milestones, and most procedures are documented and followed. Communication of risk roles is reported to work well, and strong documentation supports better team communication. The project uses expert input and risk registers, though updates are sometimes inconsistent. Training is viewed as adequate, and senior management plays an active role. Technical and human-related risks are the most significant, with financial limits, supplier delays, and subcontractor issues also affecting progress. Statistical tests show links between technical risks and supplier delays, and between financial limits and subcontractor concerns, indicating that operational and financial risks are connected. Mitigation strategies are viewed as effective, and teams understand their responsibilities. Avoidance is the most preferred response option, and the project applies data in decision-making with quick reactions to new risks. Main challenges include complex procedures, limited tools, and occasional communication gaps.

ACKNOWLEDGEMENT

I give thanks to the Divine Creator for the guidance and support that carried me through this research. I also thank Dr. Chibomba Kelvin, my research supervisor, for his support, guidance, and patience. Working under his mentorship has been an important part of this project, and I value the insights he shared with me. His input played a key role in completing this work.

REFERENCES

[1]. Akhwaba, J.K., 2020. Leadership Skills, Stakeholder Management, Project Scope and Execution of Fibre Optic Infrastructure in Nairobi County, Kenya (Doctoral dissertation, University of Nairobi).

[2]. Burgstaller, M. and Macpherson, S., 2024. How Investment Protection in Relation to Mining Projects Can Assist in Contributing to the Energy Transition. ITA Rev., 6, p.1.
[3]. Cai, M., 2024. Rockburst risk control and mitigation in deep mining. Deep Resources Engineering, p.100019.
[4]. Dua, P., 2021. Risks & Deterrents in Construction Projects: For Customers, Contractors, Suppliers & Consultants…. Notion Press.
[5]. Elbashbishy, T. and El-adaway, I.H., 2024. Skilled Worker Shortage across Key Labor-Intensive Construction Trades in Union versus Nonunion Environments. Journal of Management in Engineering, 40(1), p.04023063.
[6]. Erkul, M., Yitmen, I. and Celik, T., 2020. Dynamics of stakeholder engagement in mega transport infrastructure projects. International Journal of Managing Projects in Business, 13(7), pp.1465-1495.
[7]. Koulinas, G.K., Marhavilas, P.K., Demesouka, O.E., Vavatsikos, A.P. and Koulouriotis, D.E., 2019. Risk analysis and assessment in the worksites using the fuzzy-analytical hierarchy process and a quantitative technique–A case study for the Greek construction sector. Safety science, 112, pp.96-104.
[8]. Liswaniso, M. and Mbale, J., 2024. Leveraging Cloud Computing and Artificial Intelligence to Enhance E-Government Services in Developing Countries: Insights from Zambia. In Proceedings of International Conference for ICT (ICICT)-Zambia (Vol. 6, No. 1, pp. 39-44).
[9]. Longwe, M.D. and Tembo, S., (2022) Factors Influencing Noncompliance with Fiber Installation Guidelines by Communication Service Providers: A Case Study of Lusaka, Zambia.
[10]. Mukalula, P.M., 2020. Risk allocation decision-making in public private partnership development projects in Zambia (Doctoral dissertation, University of Zambia).
[11]. Murray, M., 2022. The Infrastructures of Security: Technologies of Risk Management in Johannesburg. University of Michigan Press.
[12]. Nachalwe, P., 2020. Management of environmental risks arising from mining operations in Kitwe and Mufulira (Doctoral dissertation, The University of Zambia).
[13]. Ngugi, A.K., 2023. Critical success factors and performance of fibre optic infrastucture projects by information and communication technology authority, kenya (Doctoral dissertation, KENYATTA UNIVERSITY).
[14]. Ofem Patrick, E., Ewa, W. and George Stephen, U., 2021. Construction Project Management in the Niger-Delta: Delays and Consequences. Journal of Architecture and Civil Engineering, 6(3), pp.01-19.
[15]. Siraj, N.B. and Fayek, A.R., 2019. Risk identification and common risks in construction: Literature review and content analysis. Journal of construction engineering and management, 145(9), p.03119004.
[16]. Van Thuyet, N., Ogunlana, S.O. and Dey, P.K., 2019. Risk management in oil and gas construction projects in Vietnam. In Risk Management in Engineering and Construction (pp. 225-247). Routledge.
[17]. Williams, T.J., 2020. Relationships Between Cost Estimates, Scheduling and Project Success in the Construction Sector (Doctoral dissertation, Walden University).
[18]. Wyllie, D.C., 2023. Risk Management for Geotechnical Engineering: Hazard, Risks and Consequences. CRC Press.
[19]. Yugay, V., Mekhtiyev, A., Madi, P., Neshina, Y., Alkina, A., Gazizov, F., Afanaseva, O. and Ilyashenko, S., 2022. Fiber-optic system for monitoring pressure changes on mine support elements. Sensors, 22(5), p.1735.
[20]. Yurchenko, A.V., Mekhtiyev, A.D., Bulatbayev, F.N., Neshina, Y.G. and Alkina, A.D., 2018. The Model of a Fiber-Optic Sensor for Monitoring Mechanical Stresses in Mine Workings. Russian Journal of Nondestructive Testing, 54, pp.528-533.
[21]. Zhang, H., Li, B., Karimi, M., Saydam, S. and Hassan, M., 2023. Recent advancements in IoT implementation for environmental, safety, and production monitoring in underground mines. IEEE Internet of Things Journal, 10(16), pp.14507-14526.
[22]. Zvarivadza, T., Onifade, M., Dayo-Olupona, O., Said, K.O., Githiria, J.M., Genc, B. and Celik, T., 2024. On the impact of Industrial Internet of Things (IIoT)-mining sector perspectives. International Journal of Mining, Reclamation and Environment, pp.1-39.