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Effectiveness of Risk Management Strategies on Project Outcomes: A Mixed-Methods Study of Contract Package 101 of the Metro Manila Subway Project

Essiah John M. Cadsawan [1, *], John Miguel P. Orilla [2], Jasmine Mickaela L. Pascua [3], Christ John L. Marcos [4]
[1, 2, 3, 4] School of Civil, Environmental, and Geological Engineering, Mapúa University, Manila, Philippines
Email: [1] emcadsawan@mymail.mapua.edu.ph, [2] jmporilla@mymail.mapua.edu.ph, [3] jmlpascua@mymail.mapua.edu.ph, [4] engr.cjlmarcos@gmail.com
*Corresponding Author

***Abstract*—The Metro Manila Subway Project (MMSP) represents a critical advancement in the Philippines' infrastructure, addressing urban congestion and improving public transportation. However, the complexities of large-scale projects like the MMSP introduce a range of risks that can impact project timelines, costs, and overall success. This study evaluates the effectiveness of Risk Management Strategies (RMS) implemented in Contract Package 101 (CP101) of the MMSP. The research identifies key risks encountered during execution, evaluates stakeholder perceptions of current mitigation controls, and analyzes on-site execution challenges. Using a mixed-methods approach, data were collected through document analysis of project reports and risk registers, semi-structured expert interviews with a site manager, and structured surveys administered to 31 site engineers and regulatory personnel. Statistical analysis, including weighted means, thematic coding, and Pearson correlation coefficients, was used to rank risk profiles and assess the significance of RMS effectiveness for project outcomes. The findings aim to provide actionable insights to optimize risk management frameworks and improve execution practices in large-scale infrastructure projects.**

Keywords—Risk Management Strategies, Metro Manila Subway Project, Large-Scale Infrastructure Project, Construction Risks

I. INTRODUCTION

Large-scale infrastructure projects play a significant role in fostering societal development by establishing the foundational systems necessary for modern living and economic growth. These projects include transportation networks, energy, water supply, and communication systems [1]. For instance, transportation networks like roads, railways, subways, and airports ensure the efficient movement of people and goods, facilitating trade, and reducing travel time. They enhance the quality of life for individuals and contribute to the overall growth of economies, enabling countries to remain competitive in an increasingly interconnected world [2]. Unlike other construction projects, these projects are complex and require significant investments in time, money, and effort. They involve extensive planning, significant resource allocation, multiple stakeholders, and lengthy execution timelines [3] [4]. By applying effective risk management strategies, potential challenges can be detected, evaluated, and resolved before they develop into significant issues.

A prime example of such an infrastructure project in the Philippines is its first underground transport system, the Metro Manila Subway Project. It is part of the Duterte Administration's Build, Build, Build program. It is a joint effort between the Department of Transportation (DOTr) and the Japan International Cooperation Agency (JICA). This subway, spanning over 33.1 km from Valenzuela to the Ninoy Aquino International Airport (NAIA), will connect 17 stations and a depot in Metro Manila [5]. Implementation will be carried out in two phases through multiple contract packages. The first phase focuses on the central zone in the North Capital Region between Valenzuela and Paranaque, while the second phase will cover the north and south zones. The MMSP Contract Package 101 (CP101) covers the construction of the first 7.3 km stretch, including the depot in Valenzuela and three stations—Quirino Highway, Tandang Sora, and North Avenue. This section will also feature six shield tunnels, connecting these stations over a span of 9.5 km [6]. The CP101 segment of the Metro Manila Subway Project is being managed and handled by a Joint Venture led by Shimizu Corporation, with its partners Fujita Corporation, Takenaka Civil Engineering & Construction Co., Ltd., and EEI Corporation [7].

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Without structured risk management strategies (RMS) that systematically identify, evaluate, and mitigate hazards, unforeseen site events can escalate into significant schedule delays, budget overruns, structural failures, and compromised site safety [8]. Managing such multifaceted uncertainties in large-scale construction requires reliable management procedures to detect site risks and prevent severe outcomes [9]. As the first underground rail system in the Philippines, the Metro Manila Subway Project faces various risks. Given its scale, this project is subject to various risks under project management, health, safety, environment, operations, and quality control and assurance. The goal of this study is to analyze the risk management strategies employed in the Metro Manila Subway Project, with a focus on identifying key risks, evaluating their impact, and assessing the effectiveness of the mitigation measures implemented to ensure project success.

I. METHODOLOGY

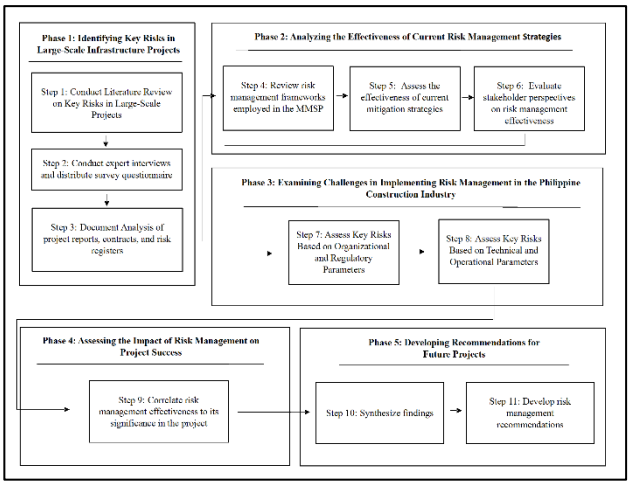


Fig. 1. *Conceptual Framework*

The study employs a mixed-method approach that integrates expert interviews, surveys, and document analysis to gather both qualitative and quantitative data [10].

A. Participants and Sampling

The survey was distributed electronically across internal team networks to maximize reach and accommodate the intensive schedules of on-site personnel. The study targeted key personnel directly involved in construction and project management for Metro Manila Subway Project Contract Package 101 (CP101). Because this electronic distribution method allowed the survey to be freely accessed and shared among qualified staff within the organization, the exact number of initial recipients could not be defined. Data collection was concluded after securing a sample of 31 responses from various project roles, including seventeen field engineers, five field supervisors, two site managers, one safety officer, one contract manager, one planning supervisor, one QA/QC engineer, one QS engineer, one contract engineer, and one warehouseman.

To complement the quantitative findings, the study integrated qualitative data obtained from an in-depth interview with a JV Site Manager, offering an experiential, high-level overview of the risk management infrastructure. This was further supported by extracting and analyzing descriptive text from the open-ended segments of the survey.

B. Key Risks in MMSP CP101

Phase 1 focuses on identifying key risks in Contract Package 101 (CP101) of the Metro Manila Subway Project. Stage 1 involves conducting a literature review to explore common risks in large-scale infrastructure projects, including organizational, technical, operational, and regulatory challenges. Stage 2 consists of expert interviews and survey distribution to gather qualitative and quantitative data from project managers, engineers, and stakeholders. Stage 3 involves document analysis of project reports, contracts, and risk registers to examine formally recognized risks and assess how they are managed within the project's risk management framework.

C. Existing Risk Management Strategies in MMSP CP101

Phase 2 analyzes the effectiveness of the risk management strategies implemented in Contract Package 101 (CP101) of the Metro Manila Subway Project. Stage 4 is to review the risk management frameworks used by the Shimizu-Fujita-Takenaka-EEI Joint Venture. This review assesses how effectively these frameworks address and mitigates the key risks identified in Phase 1. Stage 5 assesses the effectiveness of current mitigation strategies through interviews and document analysis. It examines whether the existing measures successfully minimize key risks by analyzing insights from stakeholders, project reports, and past mitigation efforts. Stage 6 evaluates stakeholder perspectives on the effectiveness of risk management. By analyzing interviews with engineers, managers, and regulatory bodies, this stage provides qualitative insights into how well the implemented strategies manage risks, prevent delays, and contribute to the overall success of the project.

After analyzing the effectiveness of the existing risk management strategies, Phase 3 examines the challenges encountered in implementing risk management strategies in CP101 MMSP. Stage 7 assesses key risks based on stakeholder feedback, particularly organizational and regulatory challenges such as financial management and compliance with safety standards. It explores the effectiveness of current risk management practices and potential difficulties in their application. Stage 8 delves into technical and operational challenges, including quality control and project delays, drawing insights from stakeholders. It highlights how existing strategies address these practical issues, identifying weaknesses and opportunities for improvement to enhance project outcomes.

D. Risk Management Strategies Framework

Building on the understanding of existing risk management strategies in CP101 of the Metro Manila Subway Project, Phase 4 develops an improved framework by assessing their impact on project success. Stage 9 establishes correlations between the effectiveness of risk management strategies and the perceived significance to the overall project success, utilizing survey data to evaluate their effectiveness in mitigating risks. Pearson correlation quantifies the relationship between risk management practices and overall project performance [11], determining the correlation coefficient (1), while descriptive analysis categorizes risk factors based on frequency and severity [12]. Thematic analysis identifies gaps and areas for improvement by drawing qualitative insights from stakeholder feedback [13].

$$R = \frac{n(\sum xy) - (\sum x)(\sum y)}{\sqrt{[n\sum x^2 - (\sum x)^2][n\sum y^2 - (\sum y)^2]}} \quad (1)$$

Phase 5 translates the findings from risk assessment into actionable recommendations for future projects. Stage 10 involves synthesizing findings from expert interviews, document analysis, and surveys to highlight key themes related to risk management in the Metro Manila Subway Project (MMSP). This synthesis will identify effective strategies, prevalent challenges, and stakeholder perspectives. Stage 11 focuses on developing risk management recommendations based on these findings. The recommendations will address identified weaknesses while leveraging successful risk mitigation strategies. By ensuring that these proposals are data-driven and aligned with stakeholder insights, this phase aims to enhance risk management practices for future projects, particularly in the extension of CP101.

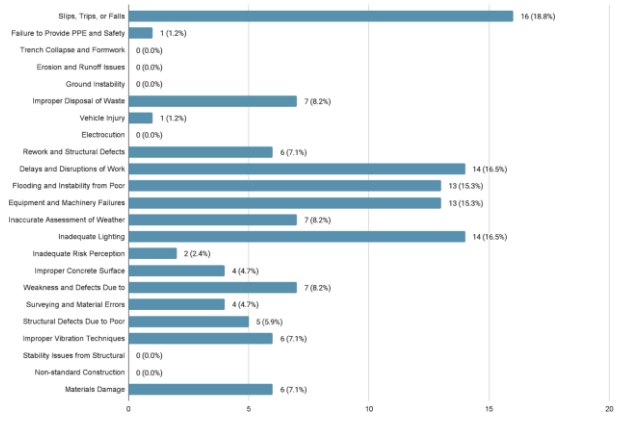


Fig. 2. *Risks encountered in the MMSP*

II. RESULTS AND DISCUSSION

Figure 2 presents the survey results on whether the listed risks were encountered in the MMSP. Among the identified risks, the most frequently encountered risk is slips, trips, or falls (18.8%), followed by inadequate lighting (16.5%), delays and disruptions of work (16.5%), flooding and instability from poor dewatering (15.3%), and equipment and machinery failures (15.3%). These risks indicate that administrative, communication, and safety-related challenges, worksite environmental conditions, and operational issues are significant concerns in the project.

On the contrary, some risks were rarely or not encountered, such as trench collapse and formwork instability, erosion and runoff issues, ground instability, electrocution, non-standard construction materials, and stability issues from structural support. This suggests that appropriate preventive measures may be in place for these particular hazards.

E. Risk Frequency and Severity

A 5-point Likert scale was utilized to evaluate both the frequency and severity of the risks encountered. The risk frequency scale ranges from 1.00-1.80 (Never), 1.81–2.60 (Rarely), 2.61–3.40 (Sometimes), 3.41–4.20 (Often), to 4.21–5.00 (Always). The severity scale spans from 1.00–1.80 (Very Low), 1.81–2.60 (Low), 2.61–3.40 (Moderate), 3.41–4.20 (High), and 4.21–5.00 (Very High).

Table 1 indicates that delays and disruptions of work are the most frequently encountered risk in the MMSP, with a weighted mean (WM) of 2.37 and a verbal interpretation (VI) of Rarely. This suggests that delays and disruptions of work, while not frequent, still occur relatively often to impact certain phases of the project, potentially causing setbacks in scheduling, coordination, and overall workflow efficiency. Additionally, flooding and instability from poor dewatering (2.33) and equipment and machinery failures (2.30) were among the most frequently reported risks, indicating that site conditions and mechanical operations may face occasional challenges.

On the other hand, several risks were never encountered in the project. Trench collapse and formwork instability (1.15), electrocution (1.23), ground instability (1.23), and erosion and runoff issues (1.23) were among the least reported, indicating strong safety measures and preventive protocols in place.

Table 1. Risk Frequency

RISKS	WM	VI	Rank
Delays and Disruptions of Work	2.37	Rarely	1
Flooding and Instability from Poor Dewatering	2.33	Rarely	2
Equipment and Machinery Failures	2.30	Rarely	3
Inadequate Lighting	2.20	Rarely	4
Slips, Trips, or Falls	2.13	Rarely	5
Inaccurate Assessment of Weather Conditions	1.97	Rarely	6
Rework and Structural Defects	1.90	Rarely	7

Surveying and Material Errors	1.87	Rarely	8
Weakness and Defects Due to Improper Joint Sealing and Grouting	1.87	Rarely	8
Inadequate Risk Perception	1.83	Rarely	9
Structural Defects Due to Poor Material Handling and Installation	1.80	Rarely	10
Materials Damage	1.73	Never	11
Improper Vibration Techniques	1.70	Never	12
Improper Concrete Surface Preparation	1.70	Never	12
Improper Disposal of Waste Materials	1.67	Never	13
Failure to Provide PPE and Safety Training	1.47	Never	14
Stability Issues from Structural Support	1.47	Never	14
Vehicle Injury	1.30	Never	15
Non-standard Construction Materials	1.27	Never	16
Ground Instability	1.23	Never	17
Erosion and Runoff Issues	1.23	Never	17
Electrocution	1.23	Never	17
Trench Collapse and Formwork Instability	1.15	Never	18

Table 2 highlights that structural defects due to poor material handling and installation were identified as the most severe risk in the MMSP, with a weighted mean of 4.00, followed closely by flooding and instability from poor dewatering (3.97). These findings suggest that construction quality control and environmental risks are critical concerns in the project. Additionally, failure to provide PPE and safety training (3.87), equipment and machinery failures (3.83), and trench collapse and formwork instability (3.83) were also ranked high, indicating that safety compliance, equipment maintenance, and site supervision are key areas requiring improvement.

On the contrary, the least severe risk identified was improper disposal of waste material (3.33), which suggests that waste management and environmental compliance is not a critical challenge compared to other risks. Additionally, inaccurate assessment of weather conditions, inadequate lighting, improper concrete surface preparation, and weakness and defects due to improper joint sealing and grouting, which all scored 3.37, were ranked lower, implying that environmental factors, site conditions, and surface preparation processes are relatively well-managed aspects of the project.

Table 2. Risk Severity

RISKS	WM	VI	Rank
Structural Defects Due to Poor Material Handling and Installation	4.00	High	1
Flooding and Instability from Poor Dewatering	3.97	High	2
Failure to Provide PPE and Safety Training	3.87	High	3
Equipment and Machinery Failures	3.83	High	4
Trench Collapse and Formwork Instability	3.83	High	4
Rework and Structural Defects	3.80	High	5
Stability Issues from Structural Support	3.77	Moderate	6
Erosion and Runoff Issues	3.77	Moderate	6
Delays and Disruptions of Work	3.73	Moderate	7
Ground Instability	3.70	Moderate	8
Surveying and Material Errors	3.70	Moderate	8
Vehicle Injury	3.60	Moderate	9
Non-standard Construction Materials	3.60	Moderate	9
Electrocution	3.57	Moderate	10
Slips, Trips, or Falls	3.53	Moderate	11
Improper Vibration Techniques	3.53	Moderate	11
Materials Damage	3.47	Moderate	12
Inadequate Risk Perception	3.43	Moderate	13
Inaccurate Assessment of Weather Conditions	3.37	Low	14
Inadequate Lighting	3.37	Low	14
Improper Concrete Surface Preparation	3.37	Low	14
Weakness and Defects Due to Improper Joint Sealing and Grouting	3.37	Low	14
Improper Disposal of Waste Materials	3.33	Low	15

Table 1 and Table 2 present frequency and severity assessments of risks identified in Contract Package 101 (CP101) of the Metro Manila Subway Project (MMSP). Comparing these tables shows a clear distinction between high-frequency, lower-severity hazards and low-frequency, high-severity risks. High-frequency risks, such as work delays, flooding, and instability from inadequate dewatering, equipment failures, and slips, trips, or falls, are recurring operational challenges during site execution. Because they occur regularly, these risks are frequently addressed in daily safety reports and toolbox meetings. However, their individual impacts are generally manageable through standard housekeeping and basic administrative controls.

On the other hand, critical hazards such as structural defects from inadequate material handling and installation, failure to provide personal protective equipment (PPE) and safety training, and trench collapse or formwork instability were assessed as having the lowest occurrence frequency. Although preventive protocols implemented by the joint venture have effectively reduced the incidence of these hazards, a single occurrence can have catastrophic consequences for project execution.

F. Risk Management Strategies

Table 3 presents the RMS formulated to address the various identified risks. These strategies were ranked based on their weighted mean of effectiveness, reflecting how well they mitigate each risk. The effectiveness scores indicate the capability of the RMS to prevent or minimize potential hazards, while the significance scores highlight the impact of these strategies on improving project outcomes. Higher rankings demonstrate a greater contribution to safety and efficiency, emphasizing the importance of prioritizing these measures for successful project execution.

Table 3. RMS Effectiveness and Significance (Weighted Mean)

Risks	RMS	Eff. (WM)	Sig. (WM)	VI

Failure to Provide PPE and Safety Training	-Supply workers with PPE, including helmets, gloves, and reflective vests. Conduct mandatory safety training. -Perform periodic audits to ensure compliance with safety measures.	4.23	4.27	Very Effective
Stability Issues from Structural Support	-After scaffolds are tagged, it should be inspected daily by the certified scaffolder inspector while in use.	4.23	4.20	Very Effective
Trench Collapse and Formwork Instability	-Conduct daily inspections to ensure bracings and supports are secure. -Use experienced personnel for formwork erection and dismantling to minimize errors.	4.17	4.20	Effective
Vehicle Injury	-Designate clear pedestrian and vehicle pathways. -Require licensed and trained operators for all construction vehicles and equipment. -Use barricades, cones, and warning signs to separate work zones from traffic areas.	4.17	4.23	Effective
Non-standard Construction Materials	-Conduct laboratory testing and obtain certifications before approving materials for use. -Vet suppliers through a rigorous qualification process, ensuring they provide reliable and consistent materials.	4.13	4.37	Effective
Delays and Disruptions of Work	-Schedule inspections well in advance and communicate timelines with all involved parties to ensure availability. -Plan schedules ahead of time, considering potential delays. -Implement a detailed checklist to verify all elements	4.13	4.13	Effective
Flooding and Instability from Poor Dewatering	-Use pumps, drains, and diversion channels to control water levels. -Monitor water levels and adjust the system during heavy rains.	4.13	4.17	Effective
Equipment and Machinery Failures	-Keep backup equipment on-site. -Conduct routine inspections before each use to identify potential issues early and prevent failures. -Assign dedicated maintenance personnel to monitor and service machinery according to a set maintenance plan.	4.13	4.07	Effective
Ground Instability	-Perform geotechnical assessments to validate compaction methods before starting work. -Use appropriate compaction equipment and ensure compaction quality is verified through testing.	4.10	4.10	Effective
Surveying and Material Errors	-Conduct surveys with calibrated equipment and experienced surveyors. -Cross-check survey data with	4.10	4.27	Effective

	as-built plans and benchmarks.			
Materials Damage	-Use appropriate lifting equipment, such as forklifts and cranes, to prevent damage during transport. -Store materials in designated, weather-protected areas with proper stacking methods to avoid breakage or deformation. -Conduct routine checks on materials before use to identify defects or damage early.	4.10	4.23	Effective
Slips, Trips, or Falls	-Maintain proper housekeeping.	4.07	4.00	Effective
Inadequate Lighting	-Maintain lighting equipment on-site specifically for night concreting activities. -Conduct lighting layout planning in advance and ensure redundancy in case of equipment failure.	4.07	4.10	Effective
Inadequate Risk Perception	-Hold daily toolbox talks to discuss site-specific risks. -Assign safety officers and supervisors to oversee and reinforce risk awareness on-site.	4.07	4.13	Effective
Structural Defects Due to Poor Material	-Perform routine checks on stored materials and address issues like bending or rust promptly. -Conduct site inspections before concrete placement to ensure proper alignment of rebar.	4.07	4.17	Effective
Electrocution	-Mark and label all electrical hazards with proper signage and warning labels. -Use proper lockout/tagout (LOTO) procedures when working on or near electrical systems.	4.03	4.13	Effective
Rework and Structural Defects	-Conduct thorough design reviews and approvals before execution -Implement quality control checks at critical stages of construction	4.03	4.07	Effective
Improper Vibration Techniques	-Conduct mock-up and vibration tests before large pours to confirm techniques are effective.	4.00	4.07	Effective
Erosion and Runoff Issues	-Schedule activities during dry weather to reduce soil erosion. -Develop a site drainage plan to control runoff.	4.00	4.13	Effective
Improper Concrete Surface Preparation	-Ensure the surface is prepared in accordance with the established inspection requirements.	3.97	4.13	Effective
Weakness and Defects Due to Improper Joint Sealing and Grouting	-Implement a post-installation inspection process.	3.97	4.07	Effective
Improper Disposal of Waste Materials	-Implement a waste management plan that includes proper collection, segregation, and disposal of scrap materials. -Reuse materials whenever possible to minimize waste.	3.83	3.87	Effective
Inaccurate Assessment of Weather Conditions	-Develop contingency plans for extreme weather,	3.60	3.87	Effective

	including temporary shelters or rescheduling. -Use materials like tarps to protect concrete during unexpected weather changes.			

G. Pearson Correlation Analysis

Table 4 shows that the Pearson correlation coefficient (R-value) is 0.775, indicating a strong positive correlation between the effectiveness of the RMS [14]. The p-value of less than 0.001 is far below the 5% level of significance, confirming that this correlation is statistically significant. [15]. This implies that as the perceived effectiveness of an RMS increases, its significance in improving project outcomes also increases.

Table 4. Relationship between the Effectiveness of the RMS and its Significance with Improved Project Outcomes

Variables	Pearson R-value	p-value	Interpretation
Effectiveness and Significance *p < 0.05*	0.775	p < 0.001	Significant

A limitation of this correlation analysis is that respondents who rate a risk management strategy as effective are likely to rate its overall significance to project performance highly as well. As a result, this statistical relationship should be interpreted as indicating the perceived contribution to project success, rather than as an objective metric of project performance. To address this limitation, future research should evaluate the effectiveness of risk management strategies using concrete performance indicators, such as measurable reductions in schedule delays or documented rates of site safety incidents.

H. Thematic Analysis

Table 5 presents a structured analysis of risk management in Contract Package 101 (CP101) of the Metro Manila Subway Project. It is organized into key themes, codes, and direct quotations. The table outlines specific risks encountered during the project, challenges faced in implementing risk management strategies, existing mitigation measures, and recommendations for improvement.

Table 5. Thematic Analysis of Risk Management in CP101 of the Metro Manila Subway Project

Theme	Code	Quotations
Key Risks	Equipment Malfunction	"For example, nagkamali ang surveyor layout. Ayan ang risk niya. Bakit? Bakit mali? Bakit magkakamali? Siguro integrity ng machine, hindi siya na-calibrate."
	Electrical hazards	"May nag-cross na electrical wiring underground. Risk din, ano rin yan. Kinuconsider din yan na risk."
	External Hazards	"Pero pumapasok pa rin ang golf ball sa site namin at marami pa ring tinatamaan. Yung equipment namin tinamaan basag yung salamin."
Challenges in Implementing Risk Management Strategies	Unforeseen Environmental Factors	"Actually nung bumaha nung ano.. nung Carina ba yon? Actually, meron kaming flood control dyan sa site na ginawa, temporary flood control…. Pero yung Carina medyo tumaas siya. Nagoverflow yung site namin na diret-diretso, hindi maiwasan."
	Overlooked Equipment Failures	"Meron kami mga incident na nagbubuhos kami, nabutas yung pump na hindi namin in-expect yan."
	Disagreements between technicians and engineers	"Dalawang tao ang nagtalo. Isang technician saka isang engineer."
	Non-compliance	"Minsan ang worker, alam nila na hindi siya safe. Pero minsan nagtataka ka bakit ginagawa pa rin nila."
Existing Risk Management Strategies	Budget Allocation	"Sa mga Japanese company, safety first talaga sila. Effective lahat kasi sa organization na meron kaming safety department may sariling budget din yan."
	Method Statement	"Actually, sabi ko kada activity may risk. Paano ma-eliminate ang risk? Gagawa ka ng method of statement, gagawa ka ng risk assessment."
	Toolbox Meeting	"Every morning may toolbox meeting lahat, part yan ng safety management."
	Safety Meeting	"Meron kaming risk management meeting lagi dyan sa site, every monthly yan." "Nagbibigay kami ng opinion bawat engineer. Then nag-decide kami, pag sinabi ng technician na hindi na pwede, stop. Kung technician okay, okay proceed."
	Safety Culture	"Pero sa amin ang slogan naman din namin is ay "don't work if it's unsafe." Hindi ako magtatrabaho pag hindi siya safe yung location."
Recommendations for Risk Management Improvement	Strengthening Flood Control Measures	"Ang budget ng preparation at flood control, para sa akin yan."
	Additional Safety in Formwork Activity	"Provide proper and secure working platform when working in elevated areas."
	Inspection of Scaffolding	"Completed scaffolding to be inspected by a certified scaffolder and if ok to use, to be fitted with a green scaff-tag."
	Operation of Concrete Pump Boom	"Only trained, authorized and competent personnel shall operate the concrete pump."

	Health Risk Management Strategies	"Also include the health risk"
	Safety Risk Management Strategies	"Safety first"
	Project Management Risk Management Strategies	"Additional Risk on Project Management or Loss Opportunities"

III. CONCLUSION

To conclude, the findings highlight the key risk factors affecting CP101 of the Metro Manila Subway Project (MMSP), emphasizing the need for a more structured and adaptable risk management approach. While routine site challenges such as work delays and slips, trips, and falls are the most frequently encountered issues, existing preventive measures effectively keep major safety incidents to a minimum. In contrast, critical hazards such as structural defects from improper material handling and flooding due to dewatering instability occur less often but have severe consequences. This inverse relationship indicates that risk management cannot rely solely on event occurrence rates, but must prioritize quality control and proactive mitigation to ensure construction safety and stability.

Current risk management measures reflect a proactive effort. Qualitative findings confirm that site protocols, such as daily toolbox meetings, monthly safety reviews, and mandatory scaff-tag inspections, effectively promote safety awareness and execution quality. However, gaps in execution, enforcement, and adaptability sustain limitations on their overall efficiency. Encouragingly, the proposed RMS framework has shown great potential in improving risk mitigation, with particularly high effectiveness in addressing critical safety concerns. Statistical analysis established a significant positive correlation between RMS effectiveness and project outcomes.

While the current risk management framework in CP101 effectively reduces routine occupational safety hazards, long-term construction safety and stability require a more adaptable approach. Comprehensive and flexible risk management is essential for addressing challenges, minimizing hazards, and ensuring successful project outcomes.

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