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RISK MANAGEMENT IN THE ANDIR RETENTION BASIN PROJECT: A QUALITATIVE CASE STUDY

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Abstract

Mega infrastructure projects in Indonesia face a complex landscape of uncertainty, often hindered by significant non-technical risks such as land acquisition and financing issues. Systematic risk management is crucial to ensure project success. This research aims to comprehensively dissect and map the risk landscape in a case study of the Andir Retention Basin Project, which reflects these challenges. Using a qualitative case study approach, this study gathered primary data through in-depth interviews with key stakeholders. Through participatory discussions, each risk was identified and assessed based on its probability and impact levels. The assessment results were then mapped onto a risk matrix to determine priority levels and formulate appropriate response strategies. The research identified 12 main risks, with five categorized as Very High: Land Acquisition, Project Financing, Regulatory Changes, Bad Weather, and Work Accidents. The main conclusion of this study is that the project's risk profile is dominated by non-technical and external factors. This finding confirms that the success of modern infrastructure projects depends not only on technical excellence but also on the management's ability to proactively navigate social, financial, and regulatory complexities.

Keywords: Risk Management, Construction Project, Infrastructure, Risk Matrix

Abstrak

Proyek infrastruktur mega di Indonesia menghadapi lanskap ketidakpastian yang kompleks, seringkali terhambat oleh risiko non-teknis yang signifikan seperti pembebasan lahan dan isu pembiayaan. Manajemen risiko yang sistematis menjadi krusial untuk menjamin keberhasilan proyek. Penelitian ini bertujuan untuk membedah dan memetakan lanskap risiko secara komprehensif pada studi kasus Proyek Kolam Retensi Andir, yang merefleksikan tantangan-tantangan tersebut. Menggunakan pendekatan studi kasus kualitatif, penelitian ini menggali data primer melalui wawancara mendalam dengan para pemangku kepentingan kunci. Melalui diskusi partisipatif, setiap risiko diidentifikasi dan dinilai berdasarkan tingkat kemungkinan dan dampaknya. Hasil penilaian tersebut kemudian dipetakan ke dalam matriks risiko untuk menentukan level prioritas dan merumuskan strategi respons yang tepat. Hasil penelitian berhasil mengidentifikasi 12 risiko utama yang dihadapi proyek. Ditemukan bahwa lima di antaranya berada pada level Sangat Tinggi, yaitu risiko terkait Pembebasan Lahan, Pembiayaan Proyek, Perubahan Regulasi, Cuaca Buruk, dan Kecelakaan Kerja. Kesimpulan utama dari studi ini adalah bahwa profil risiko proyek didominasi oleh faktor-faktor non-teknis

dan eksternal. Temuan ini menegaskan bahwa keberhasilan proyek infrastruktur modern tidak hanya bergantung pada keunggulan teknis, tetapi juga pada kemampuan manajemen untuk menavigasi kompleksitas sosial, keuangan, dan regulasi secara proaktif.
Kata Kunci : Manajemen Risiko, Proyek Konstruksi, Infrastruktur, Matriks Risiko

INTRODUCTION

The realization of mega infrastructure projects in Indonesia, as the backbone of the national development agenda and a driver of economic growth acceleration, faces an increasingly complex and multidimensional landscape of uncertainty. These challenges arise not only from the massive scale of the projects and the large investment requirements but are also exacerbated by intricate stakeholder interactions, lengthy bureaucratic licensing processes, and the high frequency of risks spanning production, financial, and socio-economic domains (Lengkong et al., 2025; Pratama & Syafri, 2025). Limited institutional capacity, regulatory misalignment, and technological readiness further slow down efforts to provide and manage national infrastructure, making development challenges demand greater innovation and cross-sector collaboration (Ervianto, 2017). Various National Strategic Projects (NSPs) that have been completed or are currently underway provide empirical evidence that fundamental obstacles often determine success or failure. Issues such as protracted land acquisition, mid-project design changes due to field adjustments, and unanticipated cost overruns frequently emerge as critical challenges that must be proactively identified and managed from the earliest planning stages (Ashadi et al., 2023; Dewi et al., 2025). The complexity of project implementation is further compounded by environmental and disaster-related issues, such as tidal flooding, coastal abrasion, and land subsidence, which are increasingly relevant for urban and coastal infrastructure (Idris, 2025).

More specifically, each risk category has deep-rooted causes. Land acquisition risk, for instance, often becomes the earliest and most difficult barrier. This process not only involves legal-formal aspects related to overlapping land ownership status but also touches on sensitive social dimensions, such as compensation price negotiations, population relocation, and potential resistance from affected communities. Failure to manage these aspects may result in multi-year project delays or even total cancellation. Socio-economic barriers in strategic urban areas require participatory and community-based approaches, as well as active mediation, to minimize resistance and conflict from the outset (Ekaterina, 2008; Syafa'at et al., 2025). From the financial perspective, infrastructure projects are highly vulnerable to macroeconomic volatility, exchange rate fluctuations, and shifts in fiscal policy. Dependence on diverse funding sources—ranging from the State Budget (APBN), State Capital Injections (PMN) to State-Owned Enterprises, and Public-Private Partnership (PPP) schemes—creates its own layer of uncertainty regarding fund availability and disbursement timelines. Alternative financing strategies and optimized investment partnerships are becoming increasingly dominant solutions in mitigating financial risks for large-scale infrastructure projects (Syafa'at et al., 2025). Meanwhile, in the production or technical domain, risks may arise from inaccurate preliminary survey data, unforeseen geological conditions, technological failures, and disruptions in the supply chain of materials and equipment.

In facing such layered complexities, disciplined and systematic risk management has shifted from being merely a best practice to becoming a fundamental prerequisite for ensuring project success. Risk management serves as a structured framework that enables project managers to identify potential threats early, analyze their likelihood and impact, and formulate effective mitigation strategies before risks materialize into actual problems. Integrated, data-driven risk management with adaptive monitoring and response mechanisms has become a key pillar in both global and national construction management (Renault & Agumba, 2016; Novita et al., 2025). This practice has proven effective in maintaining implementation stability, supporting the achievement of the project “golden triangle”—quality, cost, and time targets—and ultimately strengthening the long-term resilience of national infrastructure (Renault & Agumba, 2016; Syafa’at et al., 2025).

The Andir Retention Pond Development Project was chosen as a representative case study in this research. As an urban flood-control infrastructure project, it reflects these national challenges on a concentrated micro scale. Here, the technical complexities of construction engineering—such as large-scale excavation works, reinforced concrete structure development, and water management during construction—directly intersect with sensitive socio-economic issues. Its location within a developing urban area necessitates challenging land acquisition processes, intensive synchronization among multiple stakeholders (local government, contractors, consultants, and surrounding communities), and careful management of environmental impacts such as noise, dust, and traffic disruption (Alia et al., 2019; Ekaterina, 2008). Environmental and social risk management in this project adopts adaptive mitigation practices and cross-stakeholder communication management, in line with Sinta’s risk analysis recommendations and the latest government policies (Alia et al., 2019; Dewi et al., 2025). These layers of risk—both visible on the surface and hidden within stakeholder interactions—have the potential to become critical obstacles if not identified and managed early.

Given the urgency of empirically understanding and managing these layers of risk, this study aims to explore and map the risk landscape of the Andir Retention Pond Project. A qualitative case study approach was chosen, as it is best suited to capture the depth and richness of context from the perceptions and experiences of project actors. Unlike quantitative approaches that tend to generalize, the qualitative approach allows the researcher to explore the “why” and “how” a risk arises and is perceived by practitioners in the field. Through in-depth interviews with key stakeholders—such as project managers, chief engineers, and field supervisors—this study seeks to uncover root causes and risk perceptions directly. The collected narrative data will then be analyzed and structured using a risk matrix framework. This tool functions to translate qualitative data into an intuitive visual priority map, plotting each risk based on the combination of its probability and impact, thus serving as a foundation for adaptive and data-driven decision-making.

It is expected that this research will provide significant dual contributions. At the micro level, for the Andir Retention Pond Project itself, the analysis results will serve as a comprehensive risk register and empirical insight for formulating more targeted mitigation strategies aligned with actual field conditions. At the macro level, this case study is expected to serve as a valuable strategic reference for stakeholders in similar infrastructure projects, particularly flood-control or other water-related works in urban areas. The findings from this study may enrich the practical knowledge base in the Indonesian construction industry, assisting project managers, planners, and policymakers in enhancing preparedness and resilience in facing similar challenges in the future (Obadimu et al., 2024; Novita et al., 2025). Thus, this research not only addresses practical issues in a single project but also contributes to strengthening construction risk management practices more broadly in Indonesia.

RESEARCH METHODOLOGY

This study is designed as a qualitative case study to thoroughly examine the risk landscape of the Andir Retention Pond Project, selected for its ability to capture the complexity and context-specific nature of the phenomenon. To ensure data richness, source triangulation was applied by collecting primary data through semi-structured interviews with key actors such as the project manager, complemented by secondary data from contract documents and field reports. All qualitative data gathered were then analyzed using thematic content analysis to filter, identify, and categorize emerging risk patterns. Ultimately, each identified risk was advanced to a quantitative-descriptive assessment stage, where probability and impact scores were mapped onto a risk matrix to produce a prioritized visualization that serves as the main basis for discussion and mitigation recommendations in this study.

RESULTS AND DISCUSSION

Findings

Risk analysis in this study began with the risk identification stage using a qualitative approach. This process was based on in-depth interviews and focused discussions conducted directly with key stakeholders who possess extensive experience and a comprehensive understanding of the project, such as the Project Manager. In these interactive sessions, every potential risk that had occurred or was currently occurring in the field was explored comprehensively. The discussion did not stop at identifying the types of risks but was extended to participatory assessment. Each identified risk was then jointly evaluated with the respondents to determine its two main attributes:

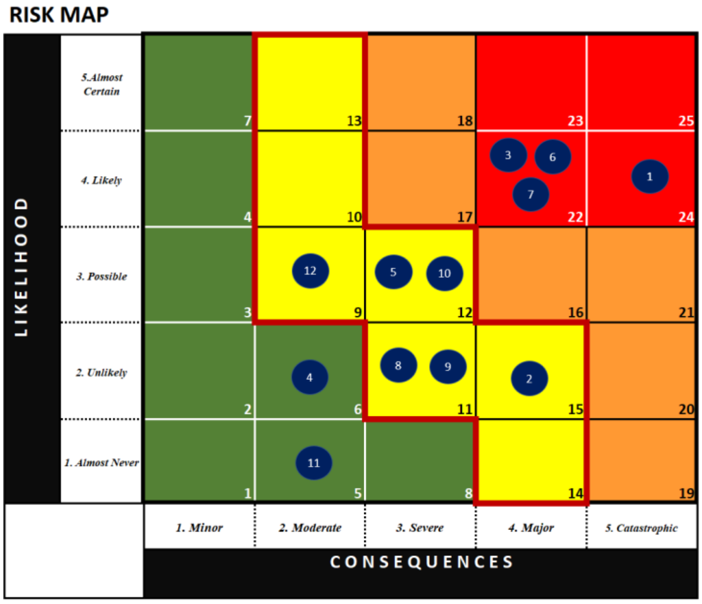
- Probability: The frequency or likelihood of a risk occurring.
- Impact: The extent of loss or negative influence the risk would have on project objectives (cost, quality, time) if it materialized.

After the probability and impact values were obtained, the risk level was determined by mapping the combination of these two scores into a risk map, which served as a project reference. Based on their positions on the map, each risk was classified into specific levels, such as Low, Moderate, High, or Very High. The final step was determining the risk response. Based on the priority level established, the project team, together with the respondents, formulated the most effective mitigation strategies for each risk.

Tabel 1. Risk Register

No	Risk Category	Risk	Likelihood	Consequense	Risk Level	Risk Response
(1)	(2)	(3)	(4)	(5)	(6)	(7)
R1	Production	Land Acquisition	4	5	VERY HIGH	Mitigate
R2	Production	Work Methods	2	4	MEDIUM	Mitigate
R3	Production	Bad Weather	4	4	VERY HIGH	Mitigate
R4	Production	Unfinalized Design	2	2	LOW	Mitigate
R5	Production	Inadequate Project Access Roads	3	3	MEDIUM	Mitigate
R6	Finance	Regulatory Changes on Tax Deductions	4	4	VERY HIGH	Accept
R7	Finance	Project Financing	4	4	VERY HIGH	Mitigate
R8	Human Resources	Lack of Certified Experts	2	3	HIGH	Transfer
R9	QHSE	Road Damage	2	3	MEDIUM	Mitigate
R10	QHSE	Work Accidents	3	3	HIGH	Mitigate
R11	QHSE	Air pollution	1	2	LOW	Mitigate

R12	QHSE	Quality	3	2	MEDIUM	Mitigate



Picture 1. Risk map

This section presents the risk data factually as identified from the risk register. These findings summarize the stakeholders' perceptions of the probability and impact of each risk before mitigation actions.

a. Identification of Very High-Risk Category

The most critical finding from the risk assessment process is the identification of five distinct risks that occupy the VERY HIGH level of the risk matrix. This concentration of high-priority threats indicates that the project is operating within a significantly challenging and volatile environment. These five risks represent the primary areas of concern that command the most significant management attention, resources, and strategic planning to prevent them from derailing the project's objectives.

- R1 - Land Acquisition: This risk was identified as the single most critical threat to the project, distinguished by a unique combination of high probability (score of 4, "Frequent") and the maximum possible impact (score of 5, "Very Large"). The "Frequent" probability score reflects the stakeholders' experience with the persistent and often unpredictable nature of land-related issues in Indonesian infrastructure projects. This is not seen as a one-time hurdle but as an ongoing process fraught with potential disputes, including overlapping ownership claims, disagreements over compensation value, and resistance from local communities. The "Very Large" impact score signifies its potential to be a project stopper. Unlike other risks that might cause delays or cost overruns, a failure to secure the required land fundamentally prevents the project from proceeding, halting all physical work, triggering contractual disputes over standing time, and potentially leading to the project's indefinite suspension or cancellation.
- R3 - Bad Weather: This risk, with a high probability (4) and large impact (4), was identified as a major, recurring operational threat. For a retention basin project involving extensive earthworks,

the term "Bad Weather" specifically refers to periods of high-intensity rainfall. The high probability score is a direct acknowledgment of the tropical climate, where seasonal monsoons and unpredictable downpours are a standard operational reality. The large impact manifests in several ways: immediate cessation of all excavation and soil compaction activities, the need for costly dewatering operations to pump out accumulated water from the project site, slope stability issues in excavated areas, and severe disruption to the logistics of material delivery due to impassable site roads. It directly affects productivity and creates significant safety hazards.

- R6 - Regulatory Changes on Tax Deductions: This financial risk was rated with high probability (4) and large impact (4), highlighting the project's vulnerability to the external macroeconomic and political environment. The "Frequent" probability score suggests a perception of instability in the national fiscal policy, where tax laws and regulations can be amended with little warning. The "Large" impact score reflects the direct and significant effect such changes can have on the project's financial viability. This could involve alterations to Value Added Tax (VAT) on materials, changes in import duties for specialized equipment, or shifts in corporate income tax regulations that directly erode the project's profitability or strain its budget.
- R7 - Project Financing: Sharing an identical high-risk profile with regulatory changes (Probability=4, Impact=4), this risk pertains to the lifeblood of the project. The high probability score does not necessarily mean a complete lack of funds, but rather the high likelihood of disruptions in the cash flow. This can be due to bureaucratic delays in the disbursement of government funds, disputes over the achievement of milestones required to trigger payments from investors, or broader economic downturns affecting the financiers' liquidity. The large impact is immediate and severe: without timely financing, the project cannot pay its contractors and suppliers, leading to work stoppages, potential legal disputes, and a loss of trust and goodwill with key partners.
- R10 - Work Accidents: This risk is uniquely categorized as "Very High" despite having moderate scores for probability (3, "Occasional") and impact (3, "Moderate"). This finding is highly significant as it reveals the project's risk tolerance calibration. It indicates that the organization places an extremely high priority on safety, where even a moderate safety incident is treated with the same level of concern as a major financial or operational risk. The impact of a work accident is understood to be multidimensional, encompassing not just the direct costs of medical treatment and work stoppage, but also the indirect costs of regulatory investigations by government bodies, damage to worker morale, and severe reputational harm to the company.

b. Identification of High, Medium, and Low-Risk Categories

Beyond the most critical threats, the assessment identified a tiered landscape of other risks requiring different levels of management attention.

- High-Risk Category: One risk was identified at the HIGH level: R8 - Lack of Certified Experts (SKA) (Probability=2, Impact=3). This risk addresses a critical human resource and compliance issue. The "Lack" refers not to a general shortage of personnel, but to a specific deficiency in staff holding the legally mandated certifications (Sertifikat Keahlian) required for overseeing or executing specialized technical work. The impact (3) is significant because proceeding without certified personnel can lead to work being legally non-compliant, rejected by supervising authorities, and potentially of substandard quality, creating a risk of future structural failure.

- Medium-Risk Category: Four risks were classified at the MEDIUM level, representing manageable, day-to-day operational challenges. These include R2 - Work Methods, which relates to inefficiencies or disputes over the chosen construction techniques; R5 - Inadequate Project Access Roads, a logistical risk that can delay the delivery of heavy equipment and bulk materials; R9 - Road Damage, which pertains to the impact of project traffic on public infrastructure and the resulting community relations issues; and R12 - Quality, a broad risk concerning the failure to meet technical specifications for materials like concrete or soil compaction, which could lead to costly rework.
- Low-Risk Category: Two risks were found to be at the LOW level: R4 - Unfinalized Design and R11 - Air Pollution. The low rating for "Unfinalized Design" suggests that, at the time of the assessment, the project was in a mature phase where the engineering and design documents were considered stable and not a significant source of uncertainty. Similarly, the low rating for "Air Pollution" (e.g., dust from earthworks) indicates that while the issue exists, its impact on the project's primary objectives of time, cost, and quality is considered minimal and can be effectively managed through standard, routine control measures like water spraying.

c. Findings Related to Risk Responses

The final component of the findings is the documentation of the strategic responses formulated by the project team for each identified risk. The pattern of these responses provides insight into the project's overall risk management philosophy.

- Mitigate: This was by far the most common response, chosen for nine of the twelve identified risks. This strategy involves taking active steps to reduce either the probability of the risk occurring or the severity of its impact, or both. The widespread application of this response indicates a proactive, hands-on management culture that seeks to actively control and influence the risk environment rather than passively reacting to it.
- Accept: This response was uniquely chosen for one risk: R6 - Regulatory Changes on Tax Deductions. The selection of this strategy for a "Very High" risk is a significant finding. It reflects a clear-eyed assessment that the risk is entirely external and beyond the project's sphere of influence. It is a conscious, strategic decision to accept the potential consequences, which is typically accompanied by the allocation of financial contingencies.
- Transfer: This response was also applied to a single risk: R8 - Lack of Certified Experts (SKA). This finding demonstrates the use of a classic risk management tool where the financial and legal responsibility for a specific risk is transferred to a third party, typically through contractual agreements like insurance or, in this case, subcontracting.

Analysis / Discussion

a. Dominance of Non-Technical Threats: Confirmation of External Complexity

An in-depth analysis of the risk register reveals a compelling narrative: the most significant threats to the Andir Retention Basin Project are not born from technical miscalculations or engineering failures, but from a volatile external environment encompassing social, legal, and financial dimensions. The fact that three of the five "Very High" level risks—Land Acquisition (R1), Tax Regulation (R6), and Project Financing (R7)—are non-technical is a powerful empirical confirmation of the initial research hypothesis. It underscores the reality that modern infrastructure projects in developing economies like

Indonesia are complex socio-technical systems where external stakeholder management and macroeconomic stability are often more critical than the construction process itself. The Land Acquisition (R1) risk, rated with the maximum possible impact score of 5, stands as the most formidable obstacle. This rating signifies that a failure in this area is not merely a setback but a potential project stopper. The high probability score (4) reflects the persistent challenges in Indonesia related to unclear land titles, lengthy negotiation processes, and the potential for social resistance from affected communities. The impact of this risk cascades catastrophically: it halts site access, invalidates schedules, incurs legal costs, and can create significant reputational damage for both the government and the contractors involved. This finding highlights that the critical path of the project does not begin with excavation, but with successful social negotiation and legal clearance. Similarly, the high ratings for Tax Regulation (R6) and Project Financing (R7) highlight the project's vulnerability to macroeconomic and political shifts. These are not risks that can be engineered away; they are systemic uncertainties that the project must navigate. This dominance of non-technical risks forces a paradigm shift in project management, demanding that project leaders possess strong skills in public relations, legal negotiation, and financial diplomacy, in addition to their core engineering expertise.

b. Strategic Intelligence and Potential Blind Spots in Risk Response

The varied choices in risk response demonstrate a sophisticated and mature strategic approach from the project team. The decision to Accept the risk of Regulatory Changes on Tax Deductions (R6) is a mark of pragmatic realism. It is an acknowledgment that the project has no control over national fiscal policy. Rather than expending resources on futile attempts to influence policy, the team accepts the risk and, ideally, prepares for its consequences through robust financial contingency planning. This is a calculated acceptance, not a passive oversight. The Transfer response for the Lack of Certified Experts (SKA) (R8) is another example of efficient and strategic risk management. It addresses a critical internal capability gap by outsourcing the risk to a third party, such as a specialized subcontractor, who contractually assumes the responsibility for providing certified personnel and guaranteeing compliance. This strategy is often faster and more cost-effective than internal recruitment or training, allowing the main contractor to focus on their core competencies while ensuring quality and legal standards are met. However, the most alarming finding is the glaring absence of a defined response for the Project Financing (R7) risk. For a threat rated as "Very High," this represents a critical gap in the risk management plan.

c. Balance of Operational Risks and Technical Team's Confidence

While external threats dominate the high-priority list, the inclusion of operational risks like Bad Weather (R3) and Work Accidents (R10) as "Very High" priorities confirms that the project team remains grounded in the day-to-day realities of construction. The high rating for bad weather is a practical acknowledgment of operating in a tropical climate, where intense rainfall can halt earthworks, compromise site safety, and disrupt logistics for extended periods. The very high priority given to work accidents, despite its moderate probability and impact scores, speaks volumes about the project's commitment to a strong safety culture. It signifies an understanding that the true impact of an accident transcends financial costs, affecting worker morale, project reputation, and regulatory standing.

Conversely, the fact that core technical risks like Work Methods (R2) and Unfinalized Design (R4) are rated as Medium to Low is highly indicative. This suggests that the project team possesses a strong degree of confidence in their internal engineering, planning, and execution capabilities. They perceive the "controllable" technical variables as being well-managed. This creates an interesting dichotomy: the team is confident in their ability to build the project correctly, but less certain about the external environment that permits them to build it at all. This highlights a mature project team that has likely mastered the technical science of construction but is now facing the more unpredictable art of managing external socio-economic forces.

d. Reflection on Subjectivity in Risk Categorization

As a final note, the categorization of Road Damage (R9) under the QHSE (Quality, Health, Safety, and Environment) category, rather than the more conventional Production or Logistics, offers a subtle but important insight. This placement suggests a specific organizational perspective. Instead of viewing road damage as a mere logistical problem (i.e., an impediment to moving materials), the team perceives it through the lens of its external impact—as a public safety hazard and an environmental disturbance to the surrounding community. This classification implies a focus on corporate social responsibility and maintaining a positive relationship with public stakeholders. It demonstrates that risk management is not a purely objective, mechanical exercise. The process of identifying, naming, and categorizing risks is inherently subjective, shaped by the organization's culture, values, past experiences, and strategic priorities. This understanding is crucial for interpreting any risk register, as it reveals not just what the risks are, but also how the organization perceives its role and responsibilities.

CONCLUSION

Based on the risk management analysis of the Andir Retention Basin Project, several main conclusions can be drawn as follows:

- Risk Profile is Dominated by Non-Technical and External Factors: This research conclusively shows that the risk landscape of the Andir Retention Basin Project has a VERY HIGH risk profile. The most critical and massively impactful sources of risk do not originate from technical construction challenges, but from external, non-technical factors, namely Land Acquisition (R1), Project Financing (R7), and Tax Regulation Changes (R6). This confirms that the project's success is highly dependent on the management's ability to handle social, economic, and regulatory aspects.
- Operational Risks Remain a Priority: Although dominated by non-technical risks, fundamental operational risks such as Bad Weather (R3) and Work Accidents (R10) remain a primary concern with a Very High risk level. This indicates that classic challenges in the construction industry remain relevant and require strong and continuous mitigation.
- Presence of Strategic Understanding but with a Critical Gap: The project team has demonstrated a strategic understanding in responding to risks, as evidenced by the variety of responses such as Mitigate, Accept, and Transfer, tailored to the characteristics of each risk.

However, the discovery of a response gap for the Project Financing (R7) risk—a risk at the Very High level—is a critical note that indicates a potential blind spot in the project's mitigation planning.

- Confirmation of Infrastructure Project Complexity: The results of this study strengthen the argument built in the background that modern infrastructure projects, especially those that interact directly with the community and government, have layers of complexity that far exceed mere technical execution on the ground.

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