

Risk Management in the Development and Operation of TPS 3R in Panjer Urban Village, Denpasar

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Received: May 4, 2025

Revised: June 29, 2025

Accepted: July 18, 2025

Abstract

The rapid urbanization in Denpasar City has intensified the challenges of municipal solid waste management, especially after the closure of the Suwung Final Disposal Site due to overcapacity. In response, the local government initiated the development of 3R-based Waste Processing Facilities (TPS 3R) at the community level, including the facility in Panjer Urban Village. However, the implementation of this community-based infrastructure project faces significant risks, ranging from technical and operational issues to social resistance. This study aims to analyze the risk management process in the development and operation of the TPS 3R Panjer, focusing on risk identification, assessment, classification, mitigation planning, and risk ownership allocation. The research employed a semi-quantitative descriptive method with a case study approach, supported by primary data from questionnaires and expert interviews. A total of 58 validated risks were assessed using a risk matrix adapted from Godfrey, combining frequency and consequence scores based on Likert scales. The results show that 67% of the identified risks fall into the "Unacceptable" and "Undesirable" categories. These risks are primarily related to community rejection, lack of technical capacity, and poor coordination. Risk mitigation strategies were formulated, and responsibilities were assigned among key stakeholders including the Public Works Department, Urban Village Office, Traditional Village leaders, Field Facilitator Team (FFT), and Community-Based Organization (CBO). The findings emphasize the importance of participatory planning, technical readiness, and structured risk control to minimize delays and cost overruns in TPS 3R implementation.

Keywords: Risk Management, TPS 3R, Risk Mitigation, Risk Allocation, Time and Cost Impact

Introduction

Urban waste generation in Denpasar City has increased significantly over the past decade, driven by population growth, economic activities, and tourism development. This has led to serious challenges in solid waste management, especially after the official closure of the Suwung Final Disposal Site (TPA Suwung) in 2021 due to environmental concerns and overcapacity. The absence of an integrated regional waste disposal system has forced the local government to adopt decentralized solutions, including the construction of 3R-based Waste Processing Facilities (TPS 3R) at the community level.

TPS 3R facilities are designed to apply the principles of Reduce, Reuse, and Recycle at the neighborhood scale, engaging local communities to manage waste from its source. One of the strategic implementations is located in Panjer Urban Village, constructed in 2022 on a land area of 11 are and funded through the National Budget (APBN). The implementation involved multiple stakeholders: the Department of Public Works and Spatial Planning (PUPR), the Panjer Urban Village Office, the Traditional Village Council, a Community-Based Organization (CBO), and the Field Facilitator Team (FFT).

Despite these efforts, the project encountered numerous obstacles, including technical shortcomings, delays in planning, social resistance, and operational inefficiencies (Patanakul, 2014). Prior research shows that many community-based infrastructure projects fail due to inadequate risk identification and response mechanisms. While risk is inherent in all infrastructure projects, its management is often overlooked in smaller-scale or decentralized initiatives. For *TPS 3R* systems, failure to manage risk can lead to community distrust, environmental impact, and financial inefficiency (Aprilia et al., 2024; Alyka & Andari, 2025; Hossain et al., 2025).

This study aims to analyze the risk management process in the development and operation of the *TPS 3R* Panjer. The objectives are: (1) to identify the dominant risks; (2) to assess and classify risks using structured tools; (3) to formulate mitigation measures; (4) to assign appropriate risk ownership; and (5) to evaluate the potential impacts of risks on project time and cost. The findings from this study are expected to serve as a practical reference for improving future *TPS 3R* planning and implementation across other urban areas in Indonesia (Raharjo et al., 2016; Zahrah et al., 2024; Amheka et al., 2015).

Theory

Risk in infrastructure projects refers to the potential deviation from planned objectives due to uncertain conditions or events (Darmawi, 2006) in Mariana (2023). In the context of community-based infrastructure such as *TPS 3R*, risks can emerge from various dimensions: technical, social, institutional, environmental, and financial. Effective risk management requires structured processes including identification, analysis, evaluation, mitigation, monitoring, and ownership assignment (Flanagan & Norman, 1993). Godfrey (1996) proposed a matrix-based risk assessment model that classifies risk based on two dimensions: frequency (likelihood) and consequence (impact severity). This model is widely applied in infrastructure development due to its adaptability to both qualitative and semi-quantitative settings. Flanagan & Norman (1993) emphasized that risks should be managed by the party most capable of controlling their outcomes. This principle is particularly relevant for decentralized, stakeholder-based projects such as *TPS 3R*. The Project Management Body of Knowledge (PMBOK® Guide) further recommends early integration of risk planning in project workflows to minimize impacts on cost, time, and performance.

Methods

This research used a semi-quantitative descriptive method with a case study approach, as recommended by Budioto and has also been applied in similar *TPS 3R* studies in Denpasar for localized infrastructure analysis. The study focused on the *TPS 3R* facility in Panjer Urban Village, Denpasar. The research process consisted of the following seven stages: (1) Literature review and preliminary interviews with stakeholders; (2) Identification of potential risks based on previous studies and observations; (3) Design and distribution of questionnaires to 35 respondents; (4) Validity and reliability testing of the questionnaire; (5) Risk scoring and classification using a risk matrix; (6) Formulation of mitigation strategies; (7) Allocation of risk ownership and analysis of time and cost impacts. The questionnaire listed 65 risk items across the planning, construction, and operational stages of the *TPS 3R* project. Respondents represented five stakeholder groups: the Department of Public Works (*PUPR*), the Urban Village Office, the Traditional Village (*Desa Adat*), the Field Facilitator Team (FFT), and the Community-Based Organization (CBO). A validity test using Pearson correlation was conducted on the questionnaire data (Sugiono, 2016). Risk items with $r\text{-count} > r\text{-table}$ (0.3338) were considered valid. A total of 58 risk items passed the test and were retained for analysis. Additionally, a reliability test using Cronbach's Alpha yielded a score of 0.882, indicating

strong internal consistency (Matondang, 2009). Each validated risk was evaluated using a 5-point Likert scale for both frequency and consequence:

Frequency: 1 = Very Rare, 2 = Rare, 3 = Occasionally, 4 = Often, 5 = Very Often

Consequence: 1 = Very Small, 2 = Small, 3 = Moderate, 4 = Large, 5 = Very Large

The total risk score for each item was calculated by multiplying frequency and consequence scores: Risk Score = Frequency × Consequence. Risk classification followed the Godfrey matrix (Godfrey et al., 1996):

Table 1. Risk Assessment and Response Classification in Organizational Risk Management

Category	Score Range	Risk Response
Unacceptable	$x \geq 15$	Must be mitigated immediately
Undesirable	$5 \leq x < 15$	Requires mitigation and regular monitoring
Acceptable	$3 \leq x < 5$	Can be tolerated under supervision
Negligible	$x < 3$	Can be ignored

Ownership of each risk was assigned to stakeholders based on their role, authority, and capacity to manage the issue (Flanagan & Norman, 1993). These included: (1) PUPR → technical planning, procurement, handover; (2) Urban Village Office → socialization, land access, community support; (3) Traditional Village → cultural and spatial legitimacy; (4) CBO → daily operations, equipment, waste handling; (5) FFT → coordination, reporting, and facilitation. The impact of the dominant risks on project cost and timeline was also analyzed using descriptive methods, expert validation, and narrative feedback from stakeholders. These risk-based consequences were cross-referenced with project delivery indicators as suggested by Yuliana (2017) and Muka (2013).

Results and Discussion

Risk Identification and Classification

A total of 65 risk items were initially developed based on literature, field observations, and expert input. After testing for validity using Pearson correlation with 35 respondents, 58 risk items were declared valid ($r\text{-count} > 0.3338$) and used for further analysis. The reliability test showed a Cronbach's Alpha of 0.882, indicating high internal consistency (Sugiono, 2016). Based on frequency and consequence scores, each risk was assigned a risk value and classified into four categories: Unacceptable, Undesirable, Acceptable, and Negligible. This classification is based on the matrix by Godfrey (Godfrey et al., 1996) and uses the scale logic described by Suliyanto (Suliyanto, 2011). Table shows the risk distribution.

Table 2. Risk Classification Based on Total Score

Risk Category	Number of Risks	Percentage
Unacceptable	10	17%
Undesirable	29	50%
Acceptable	15	26%
Negligible	4	7%
Total	58	100%

Out of the 58 risks, 39 (67%) were categorized as Unacceptable or Undesirable, requiring mitigation or close monitoring. These findings reinforce the notion that community-based infrastructure projects often face layered and unmanaged risks (Flanagan & Norman, 1993).

Risk Mitigation

Mitigation efforts were prioritized for Unacceptable risks. Examples of key risks, proposed measures, and responsible parties are presented in Table .

Table 3. Examples of Dominant Risks and Mitigation

No	Risk Description	Mitigation Strategy	Responsible Stakeholders
1	Community rejection of <i>TPS 3R</i>	Public forums, involvement of traditional leaders	Urban Village, Traditional Village
2	Inadequate equipment	Reprocurement, scheduled maintenance, operator training	CBO, <i>PUPR</i>
3	Waste not sorted at source	Awareness campaigns, monitoring, incentives	CBO, Urban Village, Community
4	Handover process delayed	SOP development, facilitation by FFT	FFT, <i>PUPR</i>
5	Poor road access to site	Infrastructure improvement, resident agreement	Urban Village, Community Leaders

Successful implementation of mitigation strategies depends on collaboration, technical readiness, and strong communication among stakeholders.

Risk Mitigation

Each of the 39 dominant risks (Unacceptable and Undesirable) was analyzed for ownership based on the stakeholder’s role, authority, and involvement. Because some risks involved multiple parties, the total number of risk allocations was 58. *Table* shows the proportional distribution based on stakeholder responsibilities.

Table4. Ownership Distribution of Dominant Risks

Stakeholder	Number of Allocations	Percentage
Community-Based Organization (CBO)	35	60%
Urban Village Office	15	26%
Field Facilitator Team (FFT)	11	19%
Local Community	8	14%
Department of Public Works (<i>PUPR</i>)	7	12%
Traditional Village	7	12%

The Community-Based Organization (CBO) remains the most dominant stakeholder, taking on 60% of the identified risk responsibilities. This is consistent with its central role in managing daily operations, waste processing, and site supervision. The Urban Village Office holds 26%, primarily handling administrative facilitation, public engagement, and land use coordination. The Field Facilitator Team (FFT) contributes 19%, particularly in facilitation and reporting. Meanwhile, the Local Community (14%), the Public Works Department (*PUPR*, 12%), and the Traditional Village (12%) handle risks associated with behavior change, technical planning, and socio-cultural acceptance. This updated distribution reflects a more balanced ownership model, affirming the importance of collaborative responsibility in managing risks in decentralized, community-based infrastructure projects.

Impact on Time and Cost

The dominant risks had measurable consequences on the *TPS 3R* project's timeline and budget. Based on stakeholder input and document review:

Time-related impacts

Delay in location approval due to resident protests. Postponed handover due to documentation and procedural gaps. Delays in training and operator deployment due to unclear schedules.

Cost-related impacts

Reprocurement of faulty or missing equipment. Extended labor contracts during idle periods. Fuel and logistics cost increases due to narrow road access. These risks reflect broader issues in community infrastructure projects. According to Yuliana (Yuliana, 2017), unmanaged operational risks significantly affect cost predictability. Muka (Muka, 2015) also noted that risk delays in urban infrastructure often stem from coordination breakdowns and social disputes.

Conclusion

This study analyzed the risk management process in the development and operation of a community-based TPS 3R facility in Panjer Urban Village, Denpasar. A total of 58 valid risk items were identified and assessed using a risk matrix that combines frequency and consequence values. The results showed that 67% of the risks were classified as Unacceptable and Undesirable, indicating a high exposure that demands immediate mitigation or strict monitoring. The dominant risks involved technical equipment failure, community rejection of the site, low participation in waste sorting, and weak coordination. These risks highlight the complexity of community-based infrastructure projects that involve multiple stakeholders and social dynamics. Mitigation strategies were developed based on stakeholder roles and risk types. Risk ownership was also allocated proportionally, with the Community-Based Organization (CBO) having the highest share of responsibility (60%), followed by the Urban Village Office (26%), Field Facilitator Team (19%), community members (14%), the Public Works Department (PUPR, 12%), and the Traditional Village (12%). This reflects the need for capacity-based and collaborative risk delegation. Furthermore, dominant risks were found to impact project delivery, causing delays in schedule and increased operational costs. These findings are in line with previous studies that emphasize the importance of integrated and participatory risk planning in decentralized urban waste systems. The results of this study can serve as a reference for stakeholders in planning, implementing, and monitoring future TPS 3R initiatives, especially those that involve active community participation in urban environments.

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