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Journal homepage: http://journal.unj.ac.id/unj/index.php/jpensil/index

RISK MANAGEMENT ANALYSIS IN SPALD-T PROJECTS: A CASE STUDY IN DKI JAKARTA

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P-ISSN: 2301-8437
E-ISSN: 2623-1085

ARTICLE HISTORY
Accepted:
14 Juli 2024
Revision:
6 Januari 2025
Published:
31 Januari 2025

ARTICLE DOI:
10.21009/jpensil.v14i1.47879

Abstract

The Centralized Domestic Wastewater Management System (SPALD-T) projects play a crucial role in improving urban sanitation but face various risks that can affect project performance. This study aims to analyze the influence of risk factors on SPALD-T project performance in DKI Jakarta. Using a quantitative approach with a cross-sectional design, data were collected through a survey of 125 members of the SPALD-T project team. The questionnaire used has undergone validity and reliability tests to ensure accurate measurement of variables. Multiple regression analysis was employed to test the relationship between risk factors and project performance. The results indicate that waste management risk has a significant and positive influence on project performance, with a regression coefficient of 0.188 and a p-value of 0.001. Meanwhile, technical risk shows a positive trend but is not statistically significant, with a regression coefficient of 0.104 and a p-value of 0.078. These findings emphasize the importance of a comprehensive risk management approach, especially in waste management aspects, to improve SPALD-T project performance. This research contributes to the development of more effective risk mitigation strategies in the context of sanitation infrastructure projects in Indonesia and highlights the need for further research on the interaction between various types of risks in influencing project performance.

Keywords: SPALD-T, risk management, project performance, sanitation infrastructure, DKI Jakarta

Introduction

Effective risk management is a crucial aspect of the success of urban infrastructure projects, including the development of the Centralized Domestic Wastewater Management System (SPALD-T). Kishk and Ukaga (2008) emphasize that effective project risk management is key to minimizing negative impacts and maximizing the chances of success in urban infrastructure projects. In this context, Tscheikner-Gratl et al (2017) add that "The development of centralized wastewater treatment systems faces various technical, financial, and social challenges that require a comprehensive risk management approach." This holistic approach is reinforced by Padilla-Rivera et al (2016), stating that risk management must consider not only technical aspects but also social and environmental impacts.

To optimize risk management in SPALD projects, several key strategies have been identified. Campos et al (2015) highlight the importance of "Identifying and analyzing risks in the early stages of the SPALD project" to enhance the likelihood of project success. Hillson and Simon (2007) recommend using systematic approaches such as the Risk Breakdown Structure (RBS) to improve decision-making accuracy in risk management. Furthermore, Ugarelli et al (Ugarelli et al., 2010) assert that "Proper implementation of risk management in SPALD projects can enhance project efficiency and reduce the likelihood of failure." Finally, the effective risk management in SPALD projects is not only beneficial for the project itself but can also contribute to improved sanitation quality and public health in urban areas (Zwikael & Ahn, 2011).

Research Methods

This study adopted a quantitative approach with a cross-sectional design to evaluate risk management in water infrastructure projects (Szymański, 2017). Data were collected through a survey to 125 respondents consisting of SPALD project teams in DKI Jakarta. The questionnaire used in this study has gone through validity and reliability tests to ensure the accuracy of the measurement of the variables studied (Hwang et al., 2014). For data analysis, multiple regression analysis was used to examine the relationship between the identified risk factors and sanitation infrastructure project performance (Sun et al., 2023).

Research Results and Discussion

Risk identification is a critical stage in project risk management for water infrastructure, allowing the project team to anticipate and manage potential threats (Shen et al., 2017). Liu et al (2018) emphasize that interviews with stakeholders are an effective method for identifying risks in SPALD projects. Tscheikner-Gratl et al (2017) categorize technical risks, including design, construction, and operational issues, while Padilla-Rivera et al (2016) highlight environmental risks, including potential pollution. Campos et al (2015) assert that a comprehensive understanding of various risk categories enables the development of more effective mitigation strategies. Cordova Jr et al (2023) add that a proactive approach can significantly enhance the chances of project success. Ogunsanmi (2011) stresses the importance of risk classification for effective management, while Hwang et al (2014) identify barriers in implementing risk management. Szymanski (2017) highlights the importance of risk management in construction projects, and Silver (2014) provide specific context for SPALD planning in Jakarta, emphasizing the importance of risk management in the local context.

Table 1. Results of Interviews with Respondents

Risk Category	Respondents	%	Key Reasons
Technical	Project Manager	25%	Uncertainty in land acquisition, wastewater treatment technology, design

	Local Government Planner	25%	Delays in land acquisition, new wastewater treatment technology, design non-compliance
	Civil Engineering Expert	25%	Delays in land acquisition, technology failure, design non-compliance
	Community Representative	25%	Pollution impact, activity disruption
Financial	Project Manager	25%	Rising material costs, project completion delays, supply material imbalance
	Local Government Planner	25%	Rising material costs, supply material imbalance
Waste Management	Civil Engineering Expert	25%	Waste treatment technology failure, high operational costs, health risks
	Community Representative	25%	Pollution impact, safe and environmentally friendly technology, community participation
Social	Community Representative	25%	Pollution impact, unclear information, lack of participation, activity disruption
	Civil Engineering Expert	25%	Social impact, community participation, outreach and education
Environmental	Environmental Technology Expert	25%	Waste treatment technology failure, unforeseen environmental impacts
	Community Representative	25%	Pollution impact, environmental sustainability, monitoring and evaluation participation

Interviews with stakeholders have proven effective in identifying risks in water infrastructure projects (Guo et al., 2014). In the context of SPALD, risks such as delays in land acquisition, technology failure, and environmental impacts are frequently identified. A deep understanding of these risks is essential for prioritizing mitigation and conflict prevention (Gharaibeh, 2014). The results of the interviews provide a solid foundation for developing risk mitigation strategies and effective resource allocation (Nguyen et al., 2020). Effective risk communication and continuous monitoring (Qazi et al., 2016) are key to project success. The information obtained must be easily understood, consistent, and valid for effective risk mitigation. Hasani (2018) emphasize that a deep understanding of risks is crucial in project management. In the context of SPALD in Jakarta, technical risks, as discussed by Renuka et al (2014), often become the primary focus. However, Boateng et al (2015) stress the importance of considering social and environmental risks. Safapour et al (Safapour et al., 2019) add that institutional and regulatory risks are also significant in the context of infrastructure projects. Financial risks, according to Haoran et al (2024), remain a major challenge in water infrastructure projects. Finally, Xuan et al (2024) emphasize the importance of asset management in long-term risk mitigation. This research identifies five main categories of risks in SPALD projects in Jakarta.

Based on the results of interviews with experts, it is noted that 100% of respondents stated that technical factors are the most dominantfactors influencing the success risk of SPALD-T projects. These include uncertainties in land acquisition, wastewater treatment technology, and design non-compliance with field conditions, all of which can potentially lead to project delays, increased costs, and disruptions to project operations.

In contrast, only 50% of experts considered other factors, such as financial, waste management, social, and environmental, to have a significant influence on project risks. Although these factors are acknowledged to contribute to risks, they are not viewed as primary elements determining overall project success. These factors mainly relate to rising costs, supply material

imbalances, as well as pollution impacts and community participation, which are deemed important but not as significant as the technical factors.

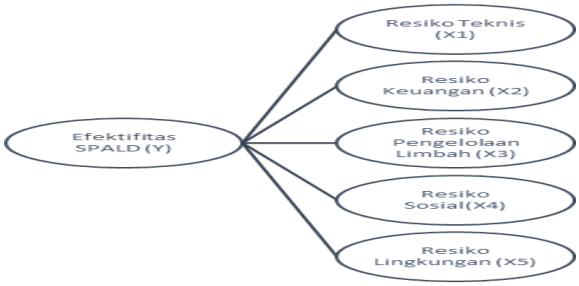

Figure 1. Risk Identification

The SPALD project in Jakarta faces various significant risks, such as delays in land acquisition, technology failures, and environmental disturbances (Guo et al., 2014). These risks can lead to project delays, increased costs, and negative impacts on the environment and community. Gharaibeh (2014) emphasizes the importance of risk identification and assessment through stakeholder surveys. Yusof et al (2018) suggests preparing a comprehensive risk management plan.

Nguyen et al (2020) emphasize the importance of developing mitigation strategies. Monitoring the effectiveness of mitigation strategies is critical. Qazi et al (2016) highlight the complexity of risks in infrastructure projects. Kang et al (2008) discuss the role of information technology in risk management.

Lawrence (2024) identify five main risk categories in infrastructure projects. Renuka et al (2014) discuss technical risks as a primary focus. Cantuaria et al (2023) stress the importance of considering social and environmental risks. van der Heijden (2021) add the significance of institutional and regulatory risks. Zhou (2023)discuss financial risks as a major challenge and emphasize the importance of asset management in long-term risk mitigation. This study identifies five main risk categories in SPALD projects in Jakarta.

Table 2. Summary of Survey Data

No	Risk Type	Respondents	SD	D	N	A	SA	Risk Score	Risk Classification
Technical Risk	1. Design, Safety	125				58	67	567	Low
	2. Planning, Security	125			13	66	46	533	Low
	3. Reliable, Adaptive	125			6	53	66	560	Low
	4. Infrastructure, Support	125			13	53	53	522	Low
Financial Risk	5. Accurate Estimation	125			33	46	46	513	Low
	6. Transparent Management	125			27	52	46	519	Low
	7. Regular Financing	125			14	66	45	531	Low
	8. Risk Mitigation	125		7	33	66	19	465	Moderate to Low
Waste Control Risk	9. Waste Capacity	125		6	7	71	41	522	Low
	10. Regulation, Processing	125			7	73	45	538	Low
	11. Health, Mitigation	125			26	60	39	513	Low
	12. Environmental Impact	125			13	74	38	525	Low
Social Risk	13. Community Participation	125			27	65	33	506	Low
	14. Conflict Mitigation	125			28	64	33	505	Low
	15. Community Support	125			27	58	40	513	Low
	16. Positive Public	125			27	52	46	519	Low
Environmental Risk	17. Water Processing	125			13	66	46	533	Low
	18. Resource Sustainability	125			26	72	27	501	Low
	19. Waste Management	125			14	58	53	539	Low
	20. Ecosystem Preservation	125			7	71	47	540	Low
	Total	3000		13	27	475	1436	1049	520.04
	Percentage (%)	3000		0.4%	0.9%	15.8%	47.9%	35.0%	Low

Terminology:

- SD (Strongly Disagree): Respondents strongly disagree.
- D (Disagree): Respondents disagree.
- N (Neutral): Respondents are neutral.

- A (Agree): Respondents agree.
- SA (Strongly Agree): Respondents strongly agree.

Score Reference:

- Low: Score > 500.
- Moderate to Low: Score 450-499.
- Moderate: Score 400-449.
- High: Score < 400.

Based on the survey, all types of risks in SPALD projects are classified as "Low," with the highest score being 540 and the lowest being 384, where the majority of respondents (47.9% - 54.0%) chose the "Low" category for each type of risk (Darko et al., 2018; Farooq et al., 2018; Patel et al., 2016). Overall, the risk level of SPALD projects is classified as "Low," which aligns with other studies showing that infrastructure projects in Indonesia generally have low-risk levels (Mohammadi et al., 2017; Yusuf et al., 2021). This risk assessment is indicative and requires further analysis to determine appropriate mitigation strategies (Iqbal et al., 2015; Sharma & Gupta, 2021).

The reliability test using Cronbach's Alpha was conducted to ensure the consistency of risk level assessment data in the SPALD project, with a Cronbach's Alpha value of 0.827, indicating good reliability according to Bonett & Wright (2015), which states that a Cronbach's Alpha value of 0.80 - 0.89 indicates good reliability (Taber, 2018; Ursachi et al., 2015). These results indicate that the risk assessment data for the SPALD project is quite consistent and reliable, thereby supporting the validity of the research findings (Balatsky et al., 2015; Bonett & Wright, 2015; Shrestha, 2021).

Table 3. Multiple Linear Regression Model

Variable	Multiple R	R Square	Adjusted R Square	Standard Error	Observations
X1	0.324	0.104	0.072	0.357	125
X2	0.275	0.076	0.044	0.363	125
X3	0.492	0.242	0.198	0.324	125
X4	0.184	0.034	0.001	0.372	125
X5	0.307	0.094	0.062	0.359	125

Table 4. Combined ANOVA

Variable	df Regression	SS Regression	MS Regression	F	Significance F	df Residual	SS Residual	MS Residual	Total
X1	1	0.208	0.208	3.44	0.078	18	1.849	0.103	2.057
X2	1	0.152	0.152	2.07	0.163	18	1.905	0.106	2.057
X3	1	0.484	0.484	5.86	0.025	18	1.573	0.087	2.057
X4	1	0.068	0.068	0.80	0.382	18	1.989	0.111	2.057
X5	1	0.188	0.188	2.76	0.112	18	1.869	0.104	2.057

Table 5. Regression Coefficients

Variable	Regression Coefficient	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept (X1)	3.342	0.236	14.16	0.000	2.876	3.808
X1 (Technical Risk)	0.104	0.054	1.93	0.078	-0.004	0.212
Intercept (X2)	3.401	0.241	14.11	0.000	2.925	3.877
X2 (Financial Risk)	-0.076	0.056	-1.36	0.163	-0.188	0.036
Intercept (X3)	2.975	0.217	13.71	0.000	2.547	3.403
X3 (Waste Management Risk)	0.188	0.049	3.84	0.001	0.091	0.285
Intercept (X4)	3.317	0.249	13.32	0.000	2.825	3.809
X4 (Social Risk)	0.052	0.056	0.93	0.382	-0.061	0.165
Intercept (X5)	3.242	0.241	13.41	0.000	2.766	3.718
X5 (Environmental Risk)	0.117	0.057	2.05	0.112	0.003	0.231

The regression analysis results for variable X1 (Technical Risk) indicate that this variable has a positive influence on the dependent variable, with a regression coefficient of 0.104. However, the p-value of 0.078 suggests that this influence is not significant at a 95% confidence level (Keshk et al., 2018; Lam & Hassan, 2019; Sinesilassie et al., 2017). This finding indicates that while there is a positive relationship between technical risk and project performance, this relationship is not strong enough to be considered statistically significant. This may be due to various other factors that also affect project performance and are not fully represented by technical risks alone (Asadi et al., 2018; Durdyev et al., 2017; Mojtahedi & Oo, 2017).

According to (Hair et al., 2021), statistical significance is crucial in regression analysis to confirm the validity of relationships between the analyzed variables. Therefore, although the results indicate a positive trend, further research with a larger sample size may be necessary to obtain more conclusive results (Agyekum et al., 2022).

Meanwhile, the regression results for variable X3 (Waste Management Risk) demonstrate a significant and positive relationship with the dependent variable, with a regression coefficient of 0.188 and a p-value of 0.001 (Junying et al., 2016; Ullah et al., 2018; Zafar et al., 2019). This finding indicates that waste management risk has a significant and positive influence on project performance and could enhance sustainability and overall project performance (Chou et al., 2018; Ekanayake et al., 2021; Oyewobi et al., 2016).

This research underscores the importance of comprehensive risk management, particularly in environmental aspects, to ensure the success of sustainable construction projects. Thus, good waste management not only mitigates negative environmental impacts but also contributes positively to overall project performance (Iqbal et al., 2015)

Conclusion

Based on the research results and discussion, it can be concluded that risk management plays a crucial role in the success of the Centralized Domestic Wastewater Management System (SPALD-T) projects in DKI Jakarta. The regression analysis shows that waste management risk has a significant and positive impact on project performance, while technical risk shows a positive trend but is not statistically significant. These findings emphasize the importance of a comprehensive risk management approach, especially in waste management aspects, to improve SPALD-T project performance (Marques & Berg, 2017; Ekanayake et al., 2020). The innovation in this study lies in the specific identification of influencing risk factors in the context of SPALD-T projects in Indonesia, which can serve as a basis for developing more effective risk mitigation strategies. Future research is recommended to conduct longitudinal studies to observe changes in risk impacts throughout the project lifecycle and explore the interactions between various types of risks in influencing SPALD-T project performance (Liu et al., 2018; Timbang et al., 2021). The practical implications of this research highlight the need for increased focus on waste management risk in the planning and implementation of SPALD-T projects, which can contribute to enhanced project efficiency and overall urban sanitation quality.

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