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Risk Identification of Private Entities in Public-Private Partnership (PPP) Projects for Water Supply Systems (SPAM)

Fakhrudin Naufal Ansori[1*], Farida Rachmawati[1]
[1]Depertemen Teknik Sipil, Institut Teknologi Sepuluh Nopember, Indonesia

*Corresponding Author's e-mail: fakhrudinnaufal919@gmail.com

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Abstract: *The development of Water Supply System (SPAM) infrastructure through the Public-Private Partnership (PPP) scheme serves as a strategic solution to the state's fiscal limitations. However, its implementation faces challenges of high-risk complexity, particularly regarding the resilience of private partners post-construction. Failure to anticipate risks from the bidding stage often leads to financial distress or service failure during the concession period. This study aims to identify and map the dominant risk profile inherent to private entities during the partner selection phase of SPAM PPP projects. Using a descriptive quantitative method, data were collected through structured questionnaires from 7 expert respondents representing key stakeholders, selected via purposive and snowball sampling techniques. Data analysis was performed by calculating the Severity Index to map risks into a probability and impact matrix. The results reveal a significant risk distribution pattern, where the majority of risks are concentrated in the red zone (high/extreme risk) and orange zone, with none in the safe zone. Specifically, the study identified three highest-risk variables: "debt burden and financial instability" (financial aspect), "lack of capability in design and construction" (technical aspect), and "weakness in water system management capability" (managerial aspect). "Debt burden and financial instability" was identified as the most critical risk in the extreme quadrant, with the highest impact of 83%. Meanwhile, socio-political risks demonstrated significant impact despite having a lower probability. This study concludes that financial stability and technical competence are "killer factors" that must be prioritized in the evaluation criteria for private entity selection. The findings recommend that the Government Contracting Agency (PJPK) tighten the selection process regarding financial and technical aspects to ensure project sustainability.*

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INTRODUCTION

The Water Supply System (SPAM) is a vital strategic infrastructure essential for achieving the Sustainable Development Goals (SDGs). However, fulfilling access to clean water in Indonesia faces severe challenges due to the government's limited fiscal capacity. Data indicates that the State Budget (APBN/APBD) is only capable of covering approximately 37% of the total national infrastructure investment requirement, leaving a massive funding deficit of 63% that must be bridged by non-government sources (Kacaribu

et al., 2022; Ray, 2015). To address this significant funding gap, the government encourages the Public-Private Partnership (PPP) scheme as a strategy to attract private investment while transferring risks to parties deemed more capable (Osei-Kyei & Chan, 2015). Although supporting regulations such as Presidential Regulation No. 38 of 2015 are in place, the implementation of PPP in the water sector possesses far more complex risk characteristics compared to other infrastructure sectors, given the socio-political sensitivity of water as a public good (Ameyaw et al., 2017).

The complexity of risks in SPAM PPP projects is empirically evident through various issues arising post-construction. The case of the Umbulan SPAM serves as tangible proof of risk asymmetry burdening the project's sustainability. An evaluation by the East Java Provincial Government in 2024 revealed a potential negative cashflow of IDR 2.08 trillion during the concession period due to the unpreparedness of downstream infrastructure and inequalities in the tariff scheme (Pj Sekda Jatim, 2024). On the other hand, technical and operational risks have also materialized in the form of reduced irrigation discharge triggering social conflicts, as well as pipeline construction quality deemed suboptimal (Radar Bromo, 2023). This phenomenon indicates that the selected Private Entity, despite meeting administrative and financial requirements during the bidding process, does not necessarily possess resilience against dynamic risks in the field.

Failure to anticipate these risks often stems from a lack of deep understanding regarding the specific risk profile inherent to Private Entities in the SPAM sector. The current prevailing paradigm tends to focus solely on financial aspects, without comprehensively dissecting the technical, operational, and environmental risks that will be faced or caused by the Private Entity (Darko et al., 2019). Consequently, risk allocation becomes inaccurate and potentially leads to financial distress or service failure in the middle of the concession period.

Therefore, a fundamental step required before designing mitigation strategies or selecting partners is to conduct precise risk identification. This study aims to identify and map the risks associated with Private Entities in SPAM sector PPP projects. This identification is crucial to fill the gap in the literature regarding the specific risk profile of the water sector in developing countries, as well as to serve as a foundation for the government (Government Contracting Agency/PJPK) in structuring more resilient and sustainable projects.

LITERATURE REVIEW

Public-Private Partnership

The Public-Private Partnership (PPP) scheme, locally known as KPBU, has become a pivotal strategy in infrastructure development in Indonesia to reduce the burden on the State Revenue and Expenditure Budget (APBN). Based on Presidential Regulation No. 38 of 2015, PPP functions not only as an alternative financing method but also aims to accelerate the provision of quality and sustainable infrastructure. The effectiveness of this model lies in its ability to drive efficiency, facilitate technology transfer, and ensure proportional risk-sharing between the government and the private sector (Rahman et al., 2019). The national PPP ecosystem is further strengthened by a technical regulatory framework through the Ministry of National Development Planning Regulation No. 4 of 2015 and guarantee support from the Indonesia Infrastructure Guarantee Fund (IIGF) to enhance project credibility in the eyes of investors (Paramita & Purwanti, 2023).

Characteristics and Challenges of PPP in the Water Supply Sector

The application of the PPP scheme in the Water Supply System (SPAM) sector has become urgent amidst the government's fiscal limitations, considering the sector's characteristics as capital intensive with a long investment payback period (Kacaribu et al., 2022; Purbo et al., 2020). To mitigate revenue risk due to social sensitivity towards water tariff increases, the Availability Payment scheme is often adopted as an alternative investment return structure (Hertati & Rachman, 2024).

However, private entity participation in SPAM faces complex challenges, ranging from uncertainty in raw water discharge and quality to technical risks in the distribution network (Wijanarko & Ye, 2023). A study on the Umbulan SPAM highlights how a decrease in water discharge and conflicts of interest can disrupt operations (Purbo et al., 2020). On the other hand, the West Semarang SPAM case study emphasizes that transaction success relies heavily on the quality of project preparation, particularly the clarity of tender documents and contract structure (Adiyanti & Fathurrahman, 2021). This issue is exacerbated by the low capacity of some local governments to compile bankable feasibility studies, which often results in project failure to reach financial close (Parlindungan et al., 2022; Ameyaw & Chan, 2013).

Risk Management

Risk management is defined as a structured process in identifying and addressing uncertainty to secure the achievement of project objectives (Mazher et al., 2022; ISO 31000). In the complex ecosystem of SPAM PPP, risk management functions as a vital instrument for measurable investment decision-making, encompassing the mitigation of technical, financial, and socio-political dynamic risks (Rezaeenour & Mousavi-Saleh, 2018; Omurzakova & Shalbolova, 2022). The effectiveness of risk management in this sector demands a profound understanding of SPAM's unique characteristics, such as raw water fluctuation and tariff sensitivity (Moradi Shahdadi et al., 2023).

To quantify these risks, a matrix-based approach measuring two main dimensions is used: probability and impact. Probability represents the frequency of the likelihood of risk occurrence based on historical data or expert judgment (Ameyaw et al., 2013), while impact measures the magnitude of consequences on cost, time, and service quality should the risk materialize (Moradi Shahdadi et al., 2023). The use of ordinal scales (e.g., a five-level scale) in this assessment aims to maintain evaluation consistency and systematically map risk mitigation priorities.

Risk Management in PPP Projects

Risk management in the PPP scheme constitutes a fundamental instrument to navigate the complexity and uncertainty of long-term infrastructure projects. Referring to the ISO 31000 standard, risk management is defined as a systematic process integrating identification, analysis, evaluation, and risk control to secure the achievement of project objectives (Mazher et al., 2022).

The criticality of risk identification during the partner selection stage is further explained by Transaction Cost Economics (TCE) and Agency Theory. In long-term concessions, information asymmetry often exists where the private sector (Agent) possesses more knowledge about its true capabilities than the government (Principal). Without precise risk identification, the project is vulnerable to adverse selection, where a partner is chosen based on a low bid rather than genuine resilience. Rigorous risk

profiling reduces these information gaps and minimizes ex-ante transaction costs, thereby preventing opportunistic behavior and renegotiations due to incomplete contracts during the concession period.

In the Indonesian context, risk management implementation faces the challenge of perception disparity between the government and private entities regarding risk allocation, particularly concerning sensitive issues such as land acquisition, construction inflation, and policy changes (Abednego & Ogunlana, 2006; Hartono & Ghifari, 2021). Inefficiency in agreeing upon this risk allocation often results in disputes or cost overruns. Therefore, Chou & Leatemia (2016) emphasize the importance of a disciplined risk management cycle, covering: (1) participatory identification, (2) qualitative-quantitative analysis, (3) impact evaluation, to (4) mitigation strategies.

The risk evaluation process generally utilizes a probability and impact matrix. Probability measures the frequency of likely occurrences, while impact measures the consequences of loss in terms of cost and time (Ameyaw et al., 2013). This structured approach has proven crucial; a study on the Solo–Yogyakarta Toll Road project shows that private entities with risk assessment maturity possess a competitive advantage during the bidding phase and are more prepared during project execution (Hartono et al., 2021). Conversely, neglecting the risk register from the early design stage can have fatal consequences, ranging from financial loss to contract termination (Tiong & Anderson, 2003).

RESEARCH METHODOLOGY

To accurately capture risk perceptions, this study employs a quantitative method based on a questionnaire survey. The respondents involved are key stakeholders representing the Government Contracting Agency (PJPK) and private entities involved in both the initiation and tender phases of SPAM PPP projects. Given the specificity of the expertise required, respondent selection was conducted using purposive sampling followed by snowball sampling. This sampling strategy is crucial to capture respondents competent in water infrastructure risk management, as well as to expand data coverage through recommendations among experts holding strategic roles in construction and investment projects.

The data analyzed in this study are primary data obtained through a questionnaire survey distributed to the Government Contracting Agency (PJPK) and Private Entities involved in SPAM PPP projects between October and December 2025. Data collection employed an expert judgment approach, where respondents were selected via purposive sampling based on their direct involvement and specific expertise in the water infrastructure sector. Given the complexity of the risk assessment model, respondent qualification is a key factor in ensuring data quality and validity.

Table 1. Respondent General Information

Respondent Information	Type	Total	Percentage
Work Unit	Government	6	86%
	Private Entity	1	14%
Education Level	Doctoral (S3)	0	0%
	Master's (S2)	4	57%
	Bachelor's (S1)	3	43%
Position	Management	2	29%

Respondent Information	Type	Total	Percentage
	Staff	5	71%
SPAM PPP Project Experience	1 to 3 Years	1	14%
	4 to 6 Years	5	71%
	More than 9 Years	1	14%

Table 2. Risk Identification in SPAM PPP Projects

No	Category	Risk	Source
A1	Financial	Debt burden and financial instability	15, 26
A2		Weak corporate financial governance	15, 26
B1	Politics and Social	Corruption	13, 4, 25, 26
B2		Conflict between private entities	13, 4, 26
C1	Technical and Experimental	Lack of experience in PPP projects	4, 25
C2		Lack of capability in design and construction	13, 4
D1	Management	Poor project management capability	15, 26
D2		Weakness in water system management capability	24, 26
E1	Environmental	Weak capability in environmental impact control	13, 25, 15

Respondents completed the questionnaire regarding the assessment of probability and impact for each identified risk using a 1-5 Likert scale. An explanation regarding the probability and impact weighting scales is presented in **Table 2** and **Table 3**.

Table 3. Risk Probability Levels

Probability	Description	Score
Very Low	Almost impossible to occur	1
Low	Possible to occur in the long term	2
Medium	May occur periodically	3
High	Frequently occurs	4
Very High	Almost certain to occur	5

(Chan et al., 2011)

Table 4. Risk Impact Levels

Impact	Description	Score
Very Low	Minimal impact	1
Low	Minor impact that can be handled easily	2
Medium	Affects several aspects of the project	3
High	Disrupts the achievement of main project objectives	4
Very High	Stops or causes project failure	5

(Chan et al., 2011)

$$SI\ (p) = \frac{\sum_i^5 a_i x_i}{5\sum_i^5 x_i} \quad \text{.....(1)}$$

$$SI\ (i) = \frac{\sum_i^5 a_i x_i}{5\sum_i^5 x_i} \quad \text{.....(2)}$$

The next step is to calculate the severity index for probability and impact using Equation 1 and Equation 2. Once the severity index values for probability and impact are obtained, these values are then matched with the probability matrix category table and the impact matrix category table, as shown in **Table 4** and **Table 5**.

Table 5. Risk Probability Scale

Probability Level	SI (%)	Scale
Almost certain to occur	81 – 100	5
Frequently occurs	61 – 80	4
May occur	41 – 60	3
Occasionally	21 – 40	2
Very rare	≤ 20	1

Table 6. Skala Dampak Risiko

Impact Level	SI (%)	Scale
Very High	81 – 100	5
High	61 – 80	4
Medium	41 – 60	3
Low	21 – 40	2
Very Low	≤ 20	1

After the probability and impact categories are obtained, the next step is to determine the risk level. Risk levels are divided into four categories: low, medium, high, and extreme. The risk levels can be more clearly observed in the probability and impact matrix table as shown in **Table 6**.

Table 7. Probability-Impact Matrix

Probability	Impact				
	1	2	3	4	5
5	H	H	E	E	E
4	M	H	H	E	E
3	L	M	H	E	E
2	L	L	M	H	E
1	L	L	M	H	H

RESULTS AND DISCUSSION

Questionnaires were distributed to 7 respondents consisting of the Government Contracting Agency (PJPK) and Private Entities involved in SPAM sector PPP projects. Data analysis for each risk category is explained in the following sub-chapters.

Table 8. Risk Probability Questionnaire Survey Results

Code	Risk	Probability							SI (p)
		Respondent No.							
		1	2	3	4	5	6	7	
A	Financial								
A1	Debt burden and financial instability	2	3	3	3	5	3	3	63%
A2	Weak corporate financial governance	2	1	2	1	5	3	4	51%
B	Politics and Social								
B1	Corruption	1	1	1	1	4	2	1	31%
B2	Conflict between private entities	1	2	1	3	4	3	1	43%
C	Technical and Experimental								

Code	Risk	Probability							SI (p)
		Respondent No.							
		1	2	3	4	5	6	7	
C1	Lack of experience in PPP projects	1	3	1	2	4	2	4	49%
C2	Lack of capability in design and construction	1	3	1	1	3	2	3	43%
D	Management								
D1	Poor project management capability	1	3	3	3	4	3	3	57%
D2	Weakness in water system management capability	1	3	2	1	4	2	3	46%
E	Environmental								
E1	Weak capability in environmental impact control	2	1	2	1	3	4	3	46%

Based on the assessment results in Table 7, a significant variation is observed regarding the perception of risk likelihood in prospective Private Entities. Generally, experts assess that risks stemming from the internal capabilities of private entities (such as financial and management) have a higher probability of occurrence compared to external risks.

The main spotlight is on Financial Risk (Code A). The "Debt burden and financial instability" indicator (A1) occupies the highest position with a probability index value of 63%. This high figure reflects the primary concern of SPAM PPP project stakeholders, namely project failure caused by private entity cash flow disruptions due to past debt burdens. Given that SPAM projects are capital intensive with long concession periods, financial stability becomes the most vulnerable foundation.

In addition to the financial aspect, Management Risk (Code D) also receives serious attention. The "Poor project management capability" indicator (D1) has a probability of occurrence of 57%. This indicates that in practice, Private Entities are often encountered that may be financially strong but weak in the managerial execution of complex projects, which ultimately leads to construction delays or operational failures.

Conversely, Socio-Political Risk (Code B), specifically the "Corruption" indicator (B1), is assessed to have the lowest probability of occurrence at 31%. This low risk perception can be interpreted to mean that the current private entity procurement mechanism is considered to have sufficiently strict regulations and transparency, or respondents view that in the context of strategic partner selection, integrity issues are relatively more controllable compared to risks of financial or technical incapacity.

Table 9. Risk Impact Questionnaire Survey Results

Code	Risk	Impact							SI (i)
		Respondent No.							
		1	2	3	4	5	6	7	
A	Financial								
A1	Debt burden and financial instability	5	3	5	2	4	5	5	83%
A2	Weak corporate financial governance	5	2	4	1	4	3	4	66%
B	Politics and Social								
B1	Corruption	3	1	4	3	4	4	3	63%
B2	Conflict between private entities	3	2	3	2	4	3	4	60%
C	Technical and Experimental								
C1	Lack of experience in PPP projects	4	3	4	3	4	2	4	69%
C2	Lack of capability in design and construction	5	3	4	4	2	4	5	77%
D	Management								
D1	Poor project management capability	4	1	4	4	4	5	3	71%
D2	Weakness in water system management capability	4	3	4	4	3	4	4	74%
E	Environmental								
E1	Weak capability in environmental impact control	5	1	4	4	4	4	4	74%

Referring to the survey results in Table 8, it is evident that experts' perceptions regarding risk impact follow a pattern converging on the aspect of project vitality. The Impact Severity Index (SI) values are generally higher than the probability values, indicating that although a risk may occur rarely, once it does, the consequences are considered extremely fatal for the project.

The most prominent finding is again observed in Financial Risk (Code A). The "Debt burden and financial instability" indicator (A1) recorded the highest impact value among all variables, at 83%. This figure confirms that in the PPP scheme, the financial health of the private entity is the "lifeblood" of the project. If the private entity experiences insolvency or default, the impact is not merely a delay, but total project termination, considering the substantial initial investment that must be borne by the private sector.

Apart from the financial aspect, Technical Risk (Code C), specifically "Lack of capability in design and construction" (C2), ranks second with an impact of 77%. This is highly logical given that SPAM infrastructure (such as Water Treatment Plants and pipeline networks) possesses precise technical specifications. Design errors not only result in rework costs but also potentially cause system failure in distributing water according to the quality and quantity standards (K3) stipulated in the long-term contract.

Interestingly, risks at the operational stage are also assessed to have an equally high impact. The indicators "Weakness in water system management capability" (D2) and "Weak capability in environmental impact control" (E1) both hold an impact value of 74%. This demonstrates respondents' awareness that failures in water and environmental management can trigger severe regulatory sanctions, including operational closure by environmental authorities.

On the other hand, Socio-Political Risks (Code B) such as "Conflict between private entities" (B2) and "Corruption" (B1) are assessed to have relatively lower impacts (60% and 63%, respectively) compared to technical and financial risks. This interpretation does not imply these risks are harmless; rather, respondents tend to view these non-technical issues as resolvable through mediation or legal channels without instantly halting project operations, unlike financial bankruptcy or structural failure, the effects of which are immediate and fatal. After calculating the risk probability and impact.

Table 10. Probability-Impact Matrix

		IMPACT				
		1	**2**	**3**	**4**	**5**
PROBABILITY	**5**					
	4					A1
	3			B2	A2, C1, D1, D2, E1, C2	
	2				B1	
	1					

Table 9 illustrates the risk distribution pattern occurring during the Private Entity selection process. The majority of risk factors are concentrated in the red zone (high/extreme risk) and the orange zone (high risk), with not a single major risk falling

into the green zone. This indicates that SPAM PPP projects possess a high level of sensitivity to failure if not managed by the right partner.

Specifically, Risk A1 (Debt burden and financial instability) occupies the most critical position in quadrant (4, 5), denoting high probability with catastrophic impact. This position leads to the conclusion that financial stability is the primary "killer factor." This financial vulnerability is further exacerbated by macroeconomic volatility, particularly interest rate fluctuations and inflation risk over the long-term concession period (typically 20–30 years). For the private sector, unmitigated inflation or rising floating interest rates can severely erode the project's Internal Rate of Return (IRR), potentially rendering the project unbankable. Consequently, in the context of selection, risks located in this coordinate are intolerable; meaning that a prospective Private Entity indicated to have issues with variable A1 or lacking hedging strategies against these long-term fiscal risks should receive a substantial score penalty or even be disqualified from the assessment model.

Furthermore, there is a dense concentration of risks at coordinate (3, 4), which also falls under the red zone category. This group encompasses a combination of secondary financial aspects (A2), technical and experimental aspects (C1, C2), managerial aspects (D1, D2), and environmental aspects (E1). These findings confirm that, in addition to capital, technical and managerial capabilities are absolute requirements that are non-negotiable.

On the other hand, an interesting shift is observed in Socio-Political Risks (Code B). Both the risk of conflict between private entities (B2) and the risk of corruption (B1) are mapped into the orange zone. This position implies an important message: although technically their probability is assessed to be lower than financial risks, their potential impact remains significant. Beyond internal conflicts, the discussion on political risk must also address the coordination friction between the Central Government and Local Governments, particularly regarding tariff adjustments. In Indonesia, drinking water tariffs are politically sensitive. Often, Local Governments face political hurdles and are reluctant to approve scheduled tariff increases despite initial agreements, which directly disrupts the revenue stream. Therefore, the inclusion of these risks in the orange zone signifies that the integrity aspect (Good Corporate Governance), political risk mitigation capability, and partner conflict management must remain the second priority assessment criteria after the technical-financial aspects, and should not be considered merely as complementary.

CONCLUSION

This study concludes that the private entity selection phase in SPAM PPP projects possesses a very high level of risk vulnerability, characterized by the dominance of risk profiles in the red zone (high/extreme risk) and orange zone, without any risk indicators falling into the safe zone. The main findings confirm that financial stability, particularly regarding debt burden and financial instability, constitutes the most critical risk factor occupying the extreme quadrant with catastrophic impact, making it an absolute requirement (intolerable risk) that is non-negotiable in partner selection. In addition to the financial aspect, technical capability in design and project management is also identified as a high-level risk demanding specific partner competence in the water sector. On the other hand, non-technical risks such as corruption and conflict between private entities, despite having a lower assessed probability of occurrence, still yield a significant impact on project sustainability.

Therefore, comprehensive mitigation strategies are required. First, the application of evaluation criteria prioritizing financial health, technical competence, and integrity (Good Corporate Governance) serves as a fundamental step that must be undertaken by the Government Contracting Agency (PJPK). Second, as a concrete policy recommendation, it is crucial to optimize the role of the Indonesia Infrastructure Guarantee Fund (IIGF/PT PII) in providing Government Guarantees. This guarantee mechanism is specifically needed to cover the "Very High" risks identified in the red zone—such as long-term financial volatility and political uncertainties—which are often beyond the control of the private entity. These combined measures are essential to mitigate potential service failures and ensure the sustainability of SPAM PPP projects.

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