

ORIGINAL RESEARCH

Risk Identification of Public Private Partnership (PPP) Project in Railway Sector Makassar–Parepare Indonesia

Yusfira Afrianti Haq* | Farida Rachmawati

¹Departement of Civil Engineering, Institut Teknologi Sepuluh Nopember, Surabaya, 60111, Indonesia, Email: yusfiraafrianti@gmail.com, farida_rahma@ce.its.ac.id

Correspondence

*Email: 6012221127@student.its.ac.id

Present Address

Gedung Teknik Sipil, Jl. Taman Alumni, Surabaya 60111, Indonesia

Abstract

Infrastructure development plays a crucial role in ensuring the sustainable economic growth of a country. For instance, Indonesia saw a 29.532% rise in infrastructure investments between 2015 and 2019, showcasing their heavy investment in infrastructure project. The Public Private Partnership (PPP) project in Indonesia is a collaborative effort between the government and private entities to enhance infrastructure project development. The Makassar-Parepare Railway Public Private Partnership (PPP) project is an example of a national strategic project on transportation sector, especially train transportation, which aims to improve the quality of national infrastructure and connectivity. However, the project faces various risks such as delays in determining the railway route and a lack of understanding of the Government Contracting Agency (GCA/PJPK) regarding the PPP concept. In order to ensure the success of this project, it is important to identify and manage these risks effectively. Utilizing the likert scale, a literature review uncovered 29 relevant risk factors, while the probability impact matrix (PIM) analysis aided in ranking the 18 main risks in the Makassar-Parepare Railway PPP project. This research can contribute to the development of more effective risk management strategies for similar infrastructure projects in the future.

KEYWORDS:

construction project, railway, public private partnership (ppp), risk management

1 | INTRODUCTION

A country's economic growth is highly dependent on sustainable infrastructure development. This is becoming increasingly relevant amidst countries' efforts to meet basic needs, and Indonesia is no exception. According to a report by the Ministry of National Development Planning (PPN), Indonesia is faced with a projected increase in infrastructure investment needs reaching 29.532%. Funds allocated for development in the 2015-2019 period from the Ministry of Finance reached IDR. 4,975.6 trillion,

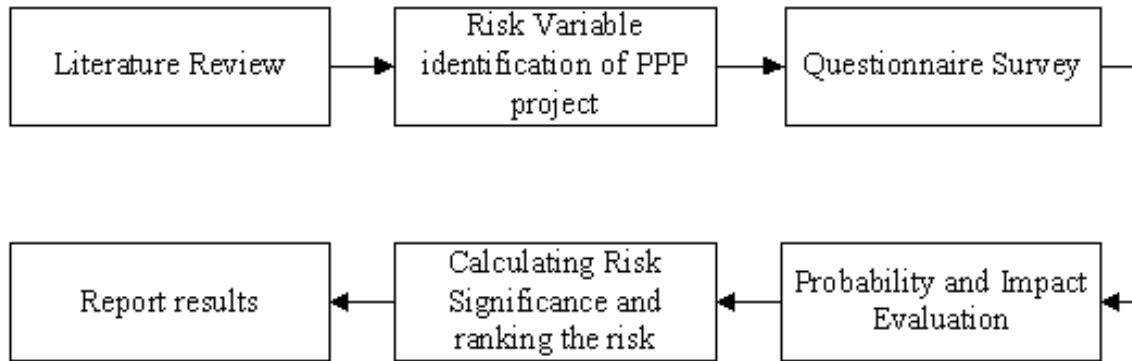


FIGURE 1 The Risk Analysis Research Methodology.

while the PPN Ministry's estimate for the 2020-2024 period jumped to IDR 6,445 trillion. One of the government's programs to improve infrastructure and investment in Indonesia is a cooperation system project involving the private sector known as Public Private Partnership (PPP). This increase in investment is the basis for the Indonesian government to improve the quality of infrastructure in all its regions with a national strategic project program, one of which is the Makassar-Parepare Railway PPP project in South Sulawesi. Central Agency of Statistics (BPS) data in the fourth quarter of 2020, the economy in Indonesia has a significant imbalance between Eastern Indonesia and Western Indonesia, where Western Indonesia's economy has reached 80.11%, while Eastern Indonesia, including Sulawesi, is still less than 20 percent. This gap causes the economy in Indonesia to be unstable. Stable, sustainable economic growth in a country cannot be separated from the contribution of infrastructure^[1]. The result of the rapidly growing population in several districts of Makassar shows the potential of the Makassar-Parepare Railway PPP Project, which is needed to reduce the burden of goods transportation on the West Sulawesi National Road by 20-30% by 2045^[2]. Even though this project is directly aimed at overcoming transportation problems, it also has a significant positive impact on strengthening national connectivity. In addition, but the government is also considering this project. The Makassar Railway PPP project has economic advantages in transportation in terms of cost and better punctuality compared to roads, highways, and toll roads^[2]. This project applies a project scheme, namely Design Build Finance Operate Maintain (DBFOM). In this scheme, the government can give authority to private parties to be responsible for the design stage through to the maintenance and operation of railway facilities and infrastructure during the term of the contract. As a result, the project is considered economically feasible, but it is not financially feasible if it is fully operated by the private sector, so government support for this project is through Availability Payment (AP) for 17 years after construction is completed^[3, 4]. Projects with the Public Private Partnership (PPP) scheme in Indonesia are described as long-term investments with planning, preparation, transaction, and maintenance stages for 20-30 years and involving many stakeholders in both the government and private sectors^[4, 5]. As a result of the complexity of PPP railway projects with long-term contracts, complicated financing processes, and project technical characteristics in a dynamic project environment, bringing challenges such as the many risks that will become inhibiting factors in the project^[6, 7]. These risks include risks in infrastructure projects with a PPP system which refer to legal and contractual regulations including immature government policies, laws, and regulations^[8-10]. A recent study highlights the obstacles in the project preparation process, especially related to the delayed determination of railway route alignments and the lack of understanding of the Government Contracting Agency (GCA/PJPK) regarding the PPP concept^[11]. In this context, the Makassar-Parepare Railway PPP project has the potential to face various risks, emphasizing the need for effective risk management or risk allocation to ensure project success and maintain sustainable relationships between the parties involved^[6]. Different projects might have specific risks and risk allocation as well. The specific risk depends on the condition and project characteristics. The first step in risk allocation requires relevant risk identification. Therefore, this research aims to identify the dominant risk factors in the Makassar-Parepare railway PPP project by conducting a comprehensive risk analysis. In this research, there are two main stages of grouping: a literature review to identify relevant risks and a probability impact matrix (PIM) for risk ranking analysis. Thus, this research seeks to contribute to the understanding of infrastructure risk management, especially in the context of railway PPPs and can become a basis for improving risk management policies and practices in the future.

2 | PREVIOUS STUDIES

Several previous studies have discussed PPP in some sectors in various parts of the world. Some studies discussed risks identification and unique challenges associated with implementing PPP projects. Some studies discussed risk identification and unique challenges associated with implementing PPP projects. There are several studies explaining the identification of risk factors and evaluating appropriate steps to handle risks in railway and other infrastructure projects by developing various decision support tools^{[8], [12–17]}. Previous study uses statistical analysis methods to examine PPP governance problems in Thailand and provide solutions for improving governance in transportation PPP projects^[10]. Another study examined how to share risks fairly for several parties involved using the value for money (VfM) method in the Korea PPP Railway Project^[18]. It should be noted that using a risk matrix supporting tool to discuss evaluating the impact of costs can influence PPP project allocations^[19]. According to previous research suggestions, it is essential to conduct risk management analysis on PPP projects with varying conditions, as stated in references^{[10], [17], [17], [19]}. PT Penjaminan Infrastruktur Indonesia also states that they are currently carrying out the first implementation of the Railway PPP Project in Indonesia^[20]. The purpose of this research is to enhance the comprehension of risk associated with PPP (Public-Private Partnership) projects, offer further contributions to the existing literature, and formulate an improved risk management strategy for future projects of the same nature. With the rapid expansion of PPP implementation across different nations, this study is anticipated to provide valuable and practical insights.

3 | METHOD

The flow diagram in Figure 1 presents how this research process was carried out. This research was divided into 2 main stages, namely risk identification is conducted using literature review and risk variable ranking using the probability impact matrix (PIM) analysis.

3.1 | Risk Identification

For the first stage of the research, a literature review was conducted using indexed international journals in construction engineering and management. The selection of these journals is generally used to conduct literature reviews and content analysis, especially related to risk in construction engineering and management by different authors^[6, 7]. The keywords used to search for articles involve Public Private Partnership (PPP) projects or Public Private Partnership (PPP) infrastructure and Public Private Partnership (PPP) railway projects. The search process was carried out using terms such as risk identification, risk assessment, risk analysis, risk management, and risk allocation. The search was carried out using the title, abstract, and keywords (T/A/K) in the search column in the search engine, with a limit of articles published from 2014 to 2023. From the selected articles, we obtained a total of 11 articles. This table lists the 9 criteria and 38 sub-criteria involved in railway PPP projects. These criteria include design and planning, location, finance, law, government regulations, politics, force majeure, construction implementation, operations, and maintenance, which were compiled from previous research to become variables in this research. These risk variables were identified through a literature review and compiled in the main questionnaire. The questionnaire was distributed to respondents from both the railway operators and the government. As previously mentioned, the railway is operated by a consortium of business entities, PT. Celebes Railway Indonesia (CRI). The government is represented by the directorate of the Ministry of Transportation. This consortium has been tasked with designing and operating the Makassar-Parepare railway PPP project. In order to be considered, respondents must have a minimum of three years of work experience in related agencies and have been involved in PPP railway projects. There were three respondents in this study, namely PT CRI Main Management, Operations & Maintenance Director, and Operations & Maintenance Manager. The results of the questionnaire were analyzed to identify the dominant risk factors in the PPP railway project.

TABLE 1 Risk Variables Identification Based on Literature Review

Code	Criteria and Sub criteria Risk	Reference
A	Design and Planning	
A1	Design variations	[8], [12], [15]–[17], [20]
A2	Delay in revising design documents	[15], [17]
A3	Misinterpretation of bid documents	[15]
A4	Errors in revising reference design documents and drawings	[15], [17]
A5	Inaccurate estimation of construction time and costs	[8], [12], [15]–[18]
B	Location	
B1	Land acquisition/land clearance	[8], [16], [17], [19], [20]
B2	Protection of historical and cultural artifacts	[12], [20]
C	Financial	
C1	Fluctuations	[8], [12], [13], [17], [18], [20]
C2	Replacement of private investors	[8], [12], [17]
C3	Inflation	[8], [10], [12], [17], [18], [20]
C4	Financial deficit	[16], [17], [19]
C5	Macro-economic risk (foreign currency exchange)	[17]
C6	Influential economic events	[17]
D	Legal	
D1	Excessive contract variations	[17]
E	Government Regulation	
E1	Unclear policies	[8], [10], [12], [14], [16], [17]
E2	Tariff restrictions	[17]
F	Political	
F1	Government corruption	[12], [13], [17]
F2	Delay in project approvals and licenses	[12], [13], [15]–[17]
F3	Lack of commitment to risk allocation	[12], [13]
F4	Government reliability	[10], [12], [13], [16], [17], [19]
F5	Government changes	[17]
F6	Political interference	[12], [13], [15], [17]
F7	Involvement in existing railway management companies	[21]
G	Force Majeure	
G1	<i>Force Majeure</i>	[8], [13], [17], [20]
H	Construction Implementation	
H1	Changes in route and rail structure design	[12], [17], [19]
H2	Lack of experience in project type	[12], [17], [19]
H3	Insufficient expertise	[12], [17], [19]
H4	Non-compliance of implementation costs with planning	[8], [16]
H5	Lack of communication	[8], [14], [15]
H6	Quality management risk (quality defects)	[14], [19]
H7	Delay in material supply	[15], [19]
H8	Lack of health and safety at the workplace	[16], [17]
H9	Long and complex completion phases	[21]
I	Operational and Maintenance	
I1	Increased operational costs	[12], [13], [16]–[19]
I2	High maintenance costs	[12], [16], [17], [19]
I3	High market demand	[16], [17]
I4	Inappropriate performance and maintenance	[12], [13], [16]–[18], [20]
I5	Lack of supporting infrastructure	[17], [19], [20]

TABLE 2 Five-point scale

Score	Scale	Impact	Probability
1	0–20%	Very low impact	Extremely ineffective
2	20–40%	Low impact	Ineffective
3	40–60%	Moderate	Moderately ineffective
4	60–80%	High impact	Very effective
5	80–100%	Very high impact	Extremely effective

TABLE 3 Risk Category

Risk Category	Range Risk Significance
Very High (VH)	17–25
High (H)	13–16
Moderate (M)	9–12
Low (L)	5–8
Very Low (VL)	1–4

3.2 | Risk Evaluation

In order to evaluate the risks associated with the railway PPP project, a variable evaluation is conducted using a questionnaire research approach. A five-point scale is used to gauge the likelihood and impact of each risk factor. This scale helps to determine the level of potential impact that each identified risk factor may have on the project. The questionnaire was distributed to five (5) respondents who are part of the consortium of business entities and have a good understanding of the actual project conditions. The second stage of the questionnaire aims to determine the level of influence that each risk factor may have on the railway PPP project. The five-point scale is used to measure probability and impact Table 2 ^[21]. Meanwhile, the risk category can be defined in Table 3 ^[22].

Once the respondents provide an assessment of each risk's likelihood and its potential impact, the next step is to determine the risk weight using the Probability Impact Matrix (PIM). To calculate the risk weight, you can use the formula^[23], in line 1.

$$\text{Risk score (R)} = \text{Probability (P)} \times \text{Impact (I)} \quad (1)$$

Where:

R = Risk significance
P = Risk probability
I = Risk impact

4 | RESULT AND DISCUSSION

The data analysis was based on main questionnaire distributed to respondents in this research. The results of the data analysis will be the basis for conducting a comprehensive discussion of each criterion, by referring to related literature that discusses the selection of sustainable business entities in global Government and Business Entity Cooperation (PPP) projects. The respondents who filled out the questionnaire have more than 9 (nine) years of working experience in PPP infrastructure, of which three years have been spent managing railway projects. The respondent also had an educational background in master's degree. A total of 38 risks were identified based on a literature review. A literature review identified a total of 38 risks, and a questionnaire survey was conducted to obtain values for the probability and impact of each risk variable. The results of the survey showed that out of the 38 risks, 29 were relevant, and these risk factors are listed in Table 4 .

TABLE 4 Result of Risk Analysis

Phase	Code	Criteria and Sub Criteria Risk	Risk Probability	Risk Impact	Risk Significance	Risk Category	Rank
Preparation	A	Design and Planning					
	A1	Design variations	5,00	5,00	25,00	VH	1
	A2	Delay in revising design documents	4,00	4,00	16,00	H	12
	A3	Misinterpretation of bid documents	4,00	3,33	13,33	H	17
	A4	Errors in revising reference design documents and drawings	4,67	3,67	17,11	VH	11
	B	Location					
	B1	Land acquisition/land clearance	5,00	4,67	23,33	VH	2
	B2	Protection of historical and cultural artifacts	1,67	1,33	2,22	VL	28
	C	Financial					
	C1	Fluctuations	4,33	3,67	15,89	H	13
	C3	Inflation	4,33	4,33	18,78	VH	7
	C5	Macro-economic risk (foreign currency exchange)	5,00	4,00	20,00	VH	6
	C6	Influential economic events	4,00	3,67	14,67	H	15
	C7	Changes in share portions	4,67	4,67	21,78	VH	3
	C8	Late of financial close	4,33	4,00	17,33	VH	10
	D	Legal					
	D1	Excessive contract variations	5,00	3,67	18,33	VH	9
	D2	Delay in availability payment (AP) acceptance	4,33	4,67	20,22	VH	5
	E	Government Regulation					
	E1	Unclear policies	2,33	2,33	5,44	L	26
	F	Politics					
	F7	Involvement in existing railway management companies	4,67	3,33	15,56	H	14
	G	Force Majeure					
	G1	<i>Force Majeure</i>	5,00	4,33	21,67	VH	4
Construction	H	Construction Implementation Risk					
	H1	Changes in route and rail structure design	4,67	4,00	18,67	VH	8
	H2	Lack of experience in project type	4,00	2,33	9,33	M	24
	H4	Non-compliance of implementation costs with planning	3,33	3,33	11,11	M	20
	H5	Lack of communication	3,67	2,67	9,78	M	23
	H6	Quality management risk (quality defects)	3,67	3,00	11,00	M	21
	H7	Delay in material supply	4,33	3,00	13,00	H	18
	H8	Lack of health and safety at the workplace	4,33	3,33	14,44	H	16
	H9	Long and complex completion phases	4,00	3,00	12,00	M	19
Operational and Maintenance	I	Operational and Maintenance Risk					
	I1	Increased operational costs	1,67	1,00	1,67	VL	29
	I2	High maintenance costs	3,33	3,00	10,00	M	22
	I3	High market demand	2,67	2,33	6,22	L	25
	I4	Inappropriate performance and maintenance	1,33	2,00	2,67	VL	27

Note: VH = Very High; H = High; M = Moderate; L = Low; VL = Very Low

A study stated that if the assessment score between two scales of agree or disagree exceeds 50%, then the score can be concluded to agree with that indicator^[24]. Based on Table 4, each risk factor has a relevant score above 0.50, which is more than 50% of the 29 risks in 9 major categories. The Makassar-Parepare Railway PPP Project comprises 3 stages: preparation, construction implementation, and maintenance and operations. These stages have 9 major categories. Out of the 29 risks, 11 risks fall in the very high-risk category, 8 risks in the high-risk category, 5 risks in the medium-risk category, 2 risks in the low-risk category,

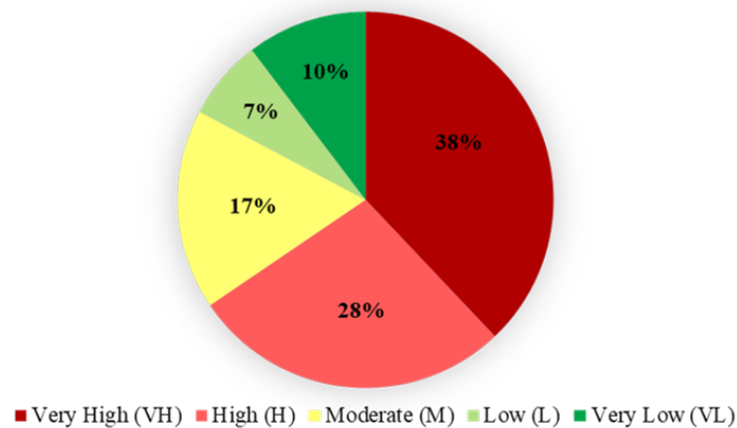


FIGURE 2 Risk Category Percentage.

and 3 risks in the very low-risk category. These risk categories are demonstrated in Figure 2. According to project management, the Makassar-Parepare Railway PPP Project has 3 stages: preparation, construction implementation, and maintenance and operations. These stages have 9 major categories, out of which 7 categories have very high and high-risk ratings. These 7 major categories are design and planning, location, financial, legal, political, force majeure, and construction implementation.

In all forms, risks always exist in every construction project, from design to operations, and cannot be eliminated^[19]. However, this can be overcome by analyzing the risk factors that influence everything. In implementing railway projects, there is a certain level of difficulty, especially in this area of construction methods. Environmental conditions are the main focus in determining the work methods to be used, where selecting the right work methods can reduce the risks of a railway project. Simple and effective risk management is important to improve risk management level performance, reduce project risks, improve quality, and be able to control the project effectively^[25]. As can be seen in Figure 2, the Makassar-Parepare PPP railway project has various risk categories. From the results of the data analysis, the Very High-risk category is 38% of the total variables, and the High-risk is 28% of all the variables. The survey results showed that each risk is assigned a risk value based on its probability and impact. Table 3 lists the top-ranked risks, which are considered very high-risk levels and are currently at the design and planning risk preparation stage. Out of the 29 risk items, there are four risks that fall under the large and very large categories. These include design variation with a risk value of 25, delay in revising design documents with a risk value of 16, misinterpretation of bid documents with a risk value of 13.33, and error in revising reference design documents and drawings with a risk value of 17.11. The main management has explained that design variations and changes could lead to delays in the project. According to Reddy and Sharma^[26] explained that the quality of design and planning in a PPP project is one of the determining factors in the process of success of the project. If the design and planning are inadequate it will cause additional costs for redesigning and carrying out approvals repeatedly which can make the project late. It is important to consider land acquisition risk assessment when evaluating location risk. In fact, this risk factor ranks second in the very high category on Table 4 with a risk value of 23.33 out of 29 risk items. Respondents have reported that during the acquisition process, the project land becomes complicated due to resistance from landowners or local communities. Therefore, it is crucial to implement careful and adaptive risk mitigation strategies to ensure smooth land acquisition and overall success of the railway PPP project^[26]. According to the survey results, the financial risk assessment for the railway PPP project has been classified as "extreme" with an overall risk rating of "very high" and "high". Table 4 depicts the value of these risks. Respondents have emphasized that due to the large number of parties involved in the PPP project, financial risks must be taken into account. Previous studies have clarified that financial risks may arise due to ambiguous financial transactions and conflicts between stakeholders in developing and operating PPP projects, resulting in bankruptcy or decreased project income^[27]. Even though financial risks have been resolved, financial problems in PPP projects still pose a threat to project sustainability^[28]. Recent findings show that PPP project managers can use the proposed maturity model as a guide to study the primary sources of financial risk and develop appropriate measures to respond to them^[29]. Sufficient training and resources can be channeled into areas where financial risk management practices are weak to achieve project success. According to the survey results, the process of allocating financial risk to the appropriate stakeholders is a step towards reducing financial risk for one of the project partners^[29]. According to risk assessment result, Table 4 shows that several sub-criteria

for legal risk have very high-risk levels. In line with that, a well-structured legal framework can encourage the private sector to enter into long-term agreements and support the resolution of any uncertainties^[30]. Therefore, it is crucial to establish an effective legal and regulatory basis by the country's legal system to develop practical contract mechanisms for PPP projects^[31]. The government needs to design a clear PPP strategy in development policy to communicate to interested parties and build on PPP principles. With clear regulations or laws, it can reduce the level of legal risk in PPP projects. Changes in legislation can create a legal framework, and these changes can have negative effects on a project^[26]. Some studies also state that PPP success depends on a stable political environment^[32]. This is particularly important for developing countries, which often rely on foreign investment through Public Private Partnerships (PPP) to fund infrastructure development. Private investors are not interested to invest to the projects in countries where the political stability is unstable. In cases where private investors do invest despite the political risks, they usually demand high rewards such as guarantees, discounts, or larger profit margins to compensate for these risks. However, the significance of managing the force majeure risk is that it can result in significant losses for private entities^[33]. During the construction phase, there are potential risks associated with the implementation of construction. These risks can lead to defects in the work, setbacks, and additional implementation costs^[26]. Therefore, to minimize these risks, it is essential to carefully select the business entities participating in the pre-qualification auction process^[34]. The process of implementing construction in railway Public-Private Partnership (PPP) projects involves various complex factors that can significantly impact progress and results, making it a high-risk venture. Changes in track design and rail structure (H1) may lead to track changes in several areas, resulting in changes in the scope of work. This necessitates a re-analysis of Capital Expenditure (CAPEX) and Operating Expenditure (OPEX). Delays in the supply of construction materials (H7) can affect the quality and smoothness of operations, while inadequate implementation of occupational health and safety (H8) can increase the risk of accidents and injuries. Previous research findings indicate that there are many obstacles in dealing with complex risk dynamics during the construction implementation process^[35]. Therefore, appropriate risk management during the construction implementation phase is crucial to minimize potential impacts and increase overall project success.

5 | CONCLUSION

Improving infrastructure in Indonesia, especially in mass transportation, is crucial for promoting long-term economic growth. Improved transportation systems are essential to enable people to move freely across regions for their daily activities. To expedite infrastructure development in Indonesia, one example is the railway PPP Project in Makassar-Parepare. The project has three stages: preparation, construction, and operations and maintenance, each with its own set of risks. Therefore, risk management is necessary to ensure that the cooperation is implemented without causing potential losses to the government and business entities. This paper examines risk values based on probability and risk impact in the railway PPP project in Makassar-Parepare, Indonesia. The study identified 38 risk factors through in-depth literature reviews to determine risk variables in the infrastructure railway PPP project. Out of the 38 risk factors, 29 relevant risk factors were found in nine broad categories, namely design and planning, location, financial, legal, government regulation, political, force majeure, construction implementation, operational, and maintenance. Risk factors were assessed based on two criteria: probability and impact. The top risks were very high at 38 percent and high risk at 28 percent of the total. According to the results of the risk significance index scores, the following risks were found to be significant: design variation (25), land acquisition/land clearance (23.33), changes in share portions (21.78), force majeure (21.67), delay in availability payment (AP) acceptance (20.22), macro-economic risk (20), inflation (18.78), changes in route and rail structure design (18.67), excessive contract variations (18.33), late financial close (17.33), errors in revising reference design documents and drawings (17.11), delay in revising design documents (16), fluctuations (15.89), involvement in existing railway management companies (15.56), influential economic events (14.67), lack of health and safety at the workplace (14.44), misinterpretation of bid documents (13.33), and delay in material supply (13.00). These findings provide a comprehensive understanding of potential risks in PPP railway projects in the region, which could contribute positively to the development of effective risk management strategies for the future in Indonesia.

CREDIT

Yusfira Afrianti Haq: Conceptualization, Methodology, Data Analysis, Writing - original draft preparation. Farida Rachmawati: Conceptualization, Methodology, Formal analysis and investigation, Reviewing-editing and Supervision.

References

1. Faradis R, Afifah UN. Indeks Komposit Pembangunan Infrastruktur Provinsi-Provinsi di Indonesia. *Jurnal Ekonomi dan Pembangunan Indonesia* 2020 Jan;20(1):33–55.
2. Andreas E, et al. Investigasi awal dan analisis gap dalam pembangunan jalur kereta api Makassar-Parepare; 2021.
3. Adam H, Wang H, Fauziah M, Suhadi O. PPP as a Creative Financing Innovation in The Financing of Makassar Parepare Railway Infrastructure. *International Journal of Business and Applied Economics* 2023 May;2(3):419–436.
4. Kementerian Keuangan RI. Dukungan Pemerintah dalam Proyek Kerjasama Pemerintah dengan Badan Usaha. Jakarta: Kementerian Keuangan Republik Indonesia; 2021.
5. Giezen M, Salet W, Bertolini L. Adding value to the decision-making process of mega projects: Fostering strategic ambiguity, redundancy, and resilience. *Transport Policy* 2015 Nov;44:169–178.
6. Li X, Wang Y. Risk Analysis in Infrastructure Projects. *Journal of Risk Research* 2021;24(3):123–135.
7. Benedictus KA, Purba H. Risk Analysis and Management in Railway Project using Tunnel Design: A Literature Review; 2019.
8. Gao Y, Lau CK. Risk Assessment of Urban Rail Transit Project Using Interpretative Structural Modelling: Evidence from China. *Mathematical Problems in Engineering* 2021;2021:5581686.
9. Liu Y, Sun C, Xia B, Liu S, Skitmore M. Identification of Risk Factors Affecting PPP Waste-to-Energy Incineration Projects in China: A Multiple Case Study. *Advances in Civil Engineering* 2018;2018:4983523.
10. Navalersuph N, Charoenngam C. Governance of Public–private partnerships in transportation infrastructure projects based on Thailand’s experiences. *Case Studies on Transport Policy* 2021 Sep;9(3):1211–1218.
11. Abdi Patu ASP, Akhmadi MH. Evaluasi Penyiapan Proyek Kerjasama Pemerintah Dengan Badan Usaha (KPBU) Kereta Api Makassar-Parepare. *Jurnal Kebijakan Pembangunan* 2021 Nov;16(2):221–235.
12. Jokar E, Aminnejad B, Lork A. Assessing and Prioritizing Risks in Public-Private Partnership (PPP) Projects Using the Integration of Fuzzy Multi-Criteria Decision-Making Methods. *Operations Research Perspectives* 2021 Jan;8:100190.
13. Sanches Vasconcelos V. Identification of the Main Risk Factors in Infrastructure Projects of Transporting People on Rail By Public-Private Partnerships; 2019.
14. Liu Z, Jiao Y, Li A, Liu X. Risk assessment of urban rail transit PPP project construction based on bayesian network. *Sustainability* 2021 Oct;13(20):11507.
15. Singh S, Johari S, Hasan A, Jha KN. Risk Factors in Dedicated Freight Corridor and Mass Rapid-Transit Metro Rail Infrastructure Projects. *Journal of Legal Affairs and Dispute Resolution in Engineering and Construction* 2022 May;14(2).
16. Babatunde SO, Perera S, Adeniyi O. Identification of critical risk factors in public-private partnership project phases in developing countries: A case of Nigeria. *Benchmarking: An International Journal* 2019 Feb;26(2):334–355.
17. Bagenda B, Ndevu Z. Principal Risks Associated with Public-Private Partnership Projects in Uganda. *Public Works Management & Policy* 2023;.
18. Lee J, Kim K, Oh J. Build Transfer Operate with risk sharing approach for railway public-private-partnership project in Korea. *Asian Transport Studies* 2022 Jan;8:100061.
19. Almarri K, Alzahrani S, Boussabaine H. An evaluation of the impact of risk cost on risk allocation in public private partnership projects. *Engineering, Construction and Architectural Management* 2019 Aug;26(8):1696–1711.
20. PT Penjaminan Infrastruktur Indonesia (Persero). Final Acuan Alokasi Risiko 2022. PT Penjaminan Infrastruktur Indonesia (Persero); 2022.

21. Kassem MA, Khoiry MA, Hamzah N. Using probability impact matrix (PIM) in analyzing risk factors affecting the success of oil and gas construction projects in Yemen. *International Journal of Energy Sector Management* 2020 Mar;14(3):527–546.
22. Nurhuda DS, Sutrisno W, Galuh DLC. Analisis Risiko Keterlambatan Waktu pada Pelaksanaan Proyek Pembangunan SPBU (Studi Kasus Di Kabupaten Bantul, Yogyakarta). *Bangun Rekaprima* 2019;5.
23. Rajpratap P, Priyan S. Risk Allocation in Public Private Partnership by Mathematical Model. *International Journal Of Multidisciplinary Research In Science, Engineering and Technology (IJMRSET)* 2019;<http://www.ijmrset.com>.
24. Triana D, Widyarto OW. Relevansi Kualifikasi Kontraktor Bidang Teknik Sipil Terhadap Kualitas Pekerjaan Proyek Konstruksi di Provinsi Banten. *Jurnal Fondasi* 2013;1.
25. Ruifang X, et al. Construction Risk Management. *Journal Title* 2011;p. 45–52.
26. Reddy NS, Sharma P. Why PPP Modeled Infrastructure Projects Failed: A Critical Review with a Special Focus on Road Sector. *International Journal of Advanced Engineering, Management and Science* 2017;3(4):331–338.
27. Aladağ H, Işık Z. Role of Financial Risks in BOT Megatransportation Projects in Developing Countries. *Journal of Management in Engineering* 2017 Jul;33(4).
28. Osei-Kyei R, Chan APC. Implementing public–private partnership (PPP) policy for public construction projects in Ghana: critical success factors and policy implications. *International Journal of Construction Management* 2017 Apr;17(2):113–123.
29. Akomea-Frimpong I, Jin X, Osei-Kyei R, Pariafsai F. Critical managerial measures on financial risks of sustainable public–private partnership projects: a PRISMA review. *Journal of Financial Management of Property and Construction* 2023 Nov;28(3):398–422.
30. Alteneiji K, Alkass S, Abu Dabous S. Critical success factors for public–private partnerships in affordable housing in the United Arab Emirates. *International Journal of Housing Markets and Analysis* 2020 Oct;13(5):753–768.
31. Zhang X. Critical Success Factors for Public–Private Partnerships in Infrastructure Development. *Journal of Construction Engineering and Management* 2005 Jan;131(1):3–14.
32. Reside RE. Global Determinants of Stress and Risk in Public-Private Partnerships (PPP) in Infrastructure. *Asian Development Bank Institute*; 2009.
33. Aziz RF. Model for Highway Construction Project Management. *Journal Title* 2016;p. 100–112.
34. Gupta AK, Trivedi M, Kansal R. Risk Variation Assessment of Indian Road PPP Projects. *International Journal of Science, Environment and Technology* 2017;2(5):1017–1026. www.ijset.net.
35. Owolabi HA, et al. Public private partnerships (PPP) in the developing world: mitigating financiers' risks. *World Journal of Science, Technology and Sustainable Development* 2019;16(3):121–141.

How to cite this article: Yusfira A. H., Farida R., (2026), Risk Identification of Public Private Partnership (PPP) Project in Railway Sector Makassar–Parepare Indonesia, *IPTEK The Journal for Technology and Science*, 37(2):114-123.



Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International ([CC BY-NC-SA 4.0](https://creativecommons.org/licenses/by-nc-sa/4.0/))

Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International (CC BY-NC-SA 4.0)