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RISK MANAGEMENT EVALUATION IN THE SENGKALING KIRI DRAINAGE REHABILITATION PROJECT ON SOEKARNO HATTA STREET MALANG

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ABSTRACT

The implementation of urban infrastructure projects has a high level of complexity that is vulnerable to various risks. This study aims to evaluate the implementation of risk management and analyze the cost of the Construction Safety Management System (SMKK) in the Sengkaling Kiri Outfall Rehabilitation Project on Soekarno Hatta Street, Malang City. This research used a descriptive evaluative method with a mixed methods approach. Quantitative analysis was conducted through questionnaires to 46 respondents to assess risk probability using the Severity Index (SI) method and probability-impact matrix based on the ISO 31000:2018 framework. Qualitative analysis was conducted through in-depth interviews with the project owner, supervisory consultant, and implementing contractor to evaluate risk management implementation. In addition, SMKK cost calculation was performed based on 9 components according to Ministerial Regulation (PUPR) Number 10 of 2021. The results showed that there were 10 high-risk variables, 20 medium-risk variables, and 2 low-risk variables out of 32 identified risk variables. The highest risks were obtained for the variables of difficulty in moving heavy equipment (R=25) and traffic congestion (R=25). Evaluation of ISO 31000:2018 implementation identified three critical gaps: reactive risk communication, risk registers not dynamically updated, and risk handling relying solely on risk reduction without avoidance or transfer. The total SMKK cost was IDR 223,414,694.00 or 0.73% of the project contract value, with the largest component being construction safety personnel (48.34%). The results provide practical recommendations for improving risk management in similar urban drainage rehabilitation projects.

***Keywords** : Risk Management, ISO 31000:2018, Urban Drainage, Post-Project Evaluation,Safety Bubdet*

1. INTRODUCTION

The implementation of urban infrastructure projects is constantly faced with uncertain environmental dynamics [1]. Technical complexity, limited space to move around, and interaction with the social and physical environment make construction projects, especially in the implementation phase, vulnerable to various types of risks [2]. In the context of urban drainage channel rehabilitation, construction work is significantly influenced by weather variables, hydrological conditions, and community activities around the project site [3]. The risks that arise tend to be multidimensional and interrelated, including fluctuations in soil conditions due to variations in groundwater levels, accumulation of standing water during the excavation process, limited accessibility of equipment and materials due to traffic congestion, and potential disruptions to existing utilities. If not managed systematically, these risks have the potential to disrupt the smooth implementation of the project and have a direct impact on the overall performance of the project [4].

The implementation of effective risk management is a key factor in ensuring the success of construction projects, especially infrastructure projects that have a direct impact on the public interest and environmental sustainability. The ISO 31000:2018 standard provides a comprehensive risk management framework through the stages of contextualization, risk identification, risk analysis, risk evaluation, and risk treatment [5]. However, in the practice of implementing urban infrastructure projects, the implementation of risk management is often still normative and not fully integrated in the managerial decision-making process and project cost control. The gap between risk planning and actual conditions on the ground has the potential to lead to deviations in project performance in terms of time, cost, and quality [4].

The Sengkaling Kiri Sewer Rehabilitation Project on Jalan Soekarno Hatta, Malang City is an urban drainage infrastructure project that has a high level of complexity. This project includes the rehabilitation of a 1,382 km channel from STA 0+000 to STA 1+382 with a contract value of IDR 30,750,595,000.00 and a plan duration of 180 calendar days from the date of the Work Commencement Order (SPMK) on

June 30, 2025 [6]. However, the project experienced a delay in completion from the plan date of December 27, 2025 to January 3, 2026, or a delay of 7 days (3.8% of the plan duration) [7]. These delays not only lead to contractual consequences, but also prolong traffic disruption and community activities around the project.

These deviations in the schedule indicate actual risks that are not fully identified and optimally managed during the project implementation phase. Most previous research on construction project risk management has focused on a prospective and planning-based approach, while studies evaluating actual risks during project implementation particularly on urban drainage rehabilitation projects have been relatively limited [8]-[10]. Therefore, retrospective risk management evaluation of completed projects is important to identify risks that actually occur in the field, analyze the managerial responses applied, and assess their impact on the performance of the project schedule.

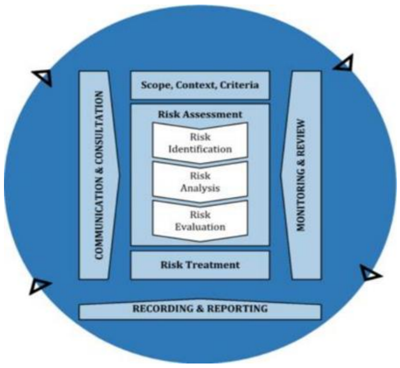
In addition to risk management evaluation, this study also calculates the cost of implementing the Construction Safety Management System (SMKK) based on 9 components of construction safety costs according to the Minister of Public Works and Housing Regulation Number 10 of 2021 as part of the implementation of construction safety in the project. The post-project evaluation is expected to provide practical and applicative lessons for improving the implementation of risk management in similar drainage rehabilitation projects in the future, particularly in strengthening the integration of managerial policies, cost control, and the implementation of the ISO 31000:2018 framework

Based on this background, the formulation of the problem in this study is: (1) What are the actual conditions of project implementation that indicate the existence of risks during the construction phase? (2) What is the level of risks identified based on probability and impact analysis during the implementation of the project? (3) How is risk management implemented in projects based on the ISO 31000:2018 framework? (4) How much the cost of implementing SMKK based on the 9 components of construction safety costs in accordance with the Minister of Public Works and Housing Regulation Number 10 of 2021?

The objectives of this study are: (1) To describe the actual conditions of project implementation that indicate the existence of risks during the construction phase; (2) Assess the level of risks identified based on probability and impact analysis during the implementation of the project; (3) Evaluate the implementation of risk management based on the ISO 31000:2018 framework; and (4) Calculating the cost of implementing SMKK based on 9 components of construction safety costs in accordance with the Minister of Public Works and Public Works Regulation Number 10 of 2021.

2. RESEARCH METHODS

2.1 Risk Management Framework



Source: Risk Management Process ISO 31000:2018

Source: ISO 31000:2018

The ISO 31000:2018 framework (Figure 1) consists of three main levels: (1) Principles that underpin the entire risk management process, (2) A framework that describes integration, design, implementation, evaluation, and continuous improvement, and (3) A process that encompasses six core components: Communication and Consultation, Scope, Context, and Criteria, Risk Assessment (Identification, Analysis, Evaluation), Risk Treatment, Monitoring and Review, and Documentation and Reporting. These six process components are cyclical and dynamic, with the results of one component serving as input for the others. In this study, these six process components were used as an evaluation rubric to measure the level of risk management implementation in the Sengkaling Kiri drainage rehabilitation project.

2.2 Research Design and Data Collection

This study is an evaluative descriptive study with a mixed methods approach and is post-project. The research location was carried out at the Sengkaling Kiri Sewer Rehabilitation Project on Jalan Soekarno Hatta, Malang City, which covers the corridor STA 0+000 to STA 1+382 with a total length of 1,382 km. This project has a contract value of IDR 30,750,595,000.00 with an implementation period from May 2025 to January 2026 [6],[7].

Data collection is carried out through primary data and secondary data. Primary data were obtained from field observations, questionnaire distribution, and in-depth interviews. The questionnaire was distributed to 46 respondents consisting of project owner staff (2 respondents), supervisory consultant staff (6 respondents), and implementing contractor staff (38 respondents), who were selected using the proportionate stratified random sampling technique based on the Slovin formula with a confidence level of 95% and a margin of error of 5%. Interviews were conducted with 3 key informants, namely the Commitment Making Officer (PPK) from the East Java Provincial Water

Resources Public Works Office, experts from PT. Wahana Prakarsa Utama as a supervisory consultant, and field implementer from PT. Bangun Konstruksi Persada as the implementing contractor. Secondary data includes project documents in the form of cost budget plans, S curves, weekly reports, Detailed Engineering Design (DED) drawings, Construction Safety Plans (RKK), and technical specifications.

The research instruments include questionnaire sheets for risk probability assessment, interview guidelines based on the ISO 31000:2018 framework, observation and documentation sheets, and SMKK cost calculation formats. The validity test of the instrument used Pearson Product Moment correlation analysis with the help of IBM SPSS Statistics 27, while the reliability test used Cronbach's Alpha coefficient. The results of the validity test showed that all 32 statements from 9 risk variables were declared valid (r count > r table = 0.297), with the lowest r value of 0.438 and the highest 1.000. The reliability test obtained a Cronbach's Alpha value = 0.866 which indicates a very high level of reliability.

2.3 Data Analysis

Data analysis was carried out quantitatively and qualitatively. Quantitative analysis includes: (1) analysis of the actual condition of the project through comparison of plan progress and realization; (2) risk level analysis by calculating the probability Severity Index (SI) based on respondents' assessments, impact assessments by researchers based on the actual conditions of the project, and determination of risk levels (R = P × I) using a probability-impact matrix; and (3) the calculation of SMKK costs based on 9 components in accordance with the Minister of PUPR Number 10 of 2021 using the unit price of Malang City work in 2025. Qualitative analysis was conducted to evaluate the implementation of risk management based on 6 ISO 31000:2018 processes through in-depth interviews and project documentation.

3. RESULTS AND DISCUSSION

3.1 Actual Conditions of Project Implementation

Based on the analysis of secondary data in the form of weekly progress reports and S curves, an overview of the actual conditions of project implementation was obtained that showed the existence of deviations between plan and realization. Table 1 presents a recapitulation of the cumulative progress of the plan and its realization in the critical period of project implementation.

Tabel 1. Recapitulation of Cumulative Progress of Plans & Realization

Week	Date	Plan (%)	Realization (%)	Deviation (%)
8	18 August 24 August	5,484	1,514	−3,970
10	01 September - 07 September	13,777	3,242	−10,535
14	September - 05 October	33,314	11,589	−21,725
17	20 Oktober – 26 Oktober	56,339	33,595	−22,744
19	20 October - 26 October	72,413	42,945	−29,468
20	10 November - 16 November	80,666	55,275	−25,391

Sources: Weekly Progress Report PT. Bangun Konstruksi Persada, 2025

The largest deviation occurred in week 19 with a value of −29.468%, which indicates that the realization of progress has experienced significant deviations from the plan. This condition shows that the project is in a critical phase of the implementation of the main work, namely the installation of a U-ditch channel which has high complexity and requires intensive coordination with dynamic field conditions. The accumulation of barriers in that period reflects actual risks that are not optimally managed.

Based on field observations, three actual conditions were identified that indicated the existence of material risks during the implementation of the project. First, the occurrence of traffic jams during the implementation of the work (variable X7-1). Construction activities involving open excavation, material placement, and mobilization of heavy equipment caused the narrowing of the road body on the Soekarno Hatta Street corridor which is the main route with a high level of traffic. This has an impact on reducing road capacity and increasing vehicle density, especially during peak hours, and has the potential to hinder material distribution and labor mobilization.

Second, the discovery of underground utilities in the form of active PDAM pipes in the excavation area (variable X5-5) which based on the results of interviews have not been optimally identified at the planning stage. This discovery led to the work being temporarily halted for further treatment, such as coordination with relevant parties and adjustments to work methods, which had a direct impact on delays in implementation time and potential increased project costs.

Third, unpredictable weather barriers (variable X2-1) during the rainy season which result in waterlogging in the excavation area and interfere with the smooth running of the work. These three actual conditions are not just operational bottlenecks, but rather manifestations of risks that have been identified in research instruments and proven to have a significant impact on project time performance

3.2 Identify Risks

Risk identification is the initial stage to conduct a risk assessment through a literature review. The purpose of this stage is to identify the risks that generally occur in the Sengkaling Kiri Sewer Rehabilitation Project on Jalan Soekarno Hatta, Malang City. It was identified by providing a questionnaire to assess the probability of risk to the respondents, the service user (owner), the work supervisor (consultant), and the service provider (contractor). The following are the results of risk identification in Table 2.

Tabel 2. Riks Variabel

Code	Risk Variable
X1	**Contractual Risk**
X1-1	Challenges in Obtaining Permits for Project Implementation
X1-2	Changes in government regulations/laws trade related to project implementation
X1-3	Ambiguity in the provisions of the project contract
X2	**Unexpected Risks**
X2-1	Work delays caused by unpredictable weather (rain and flooding)
X3	**Human Error**
X3-1	Exhaustion caused by working long hours
X3-2	Low labor productivity
X3-3	Delays in the delivery of materials that hinder project progress
X3-4	Contract amendment administrative process
X4	**Project Risks**
X4-1	Discrepancies between field measurement data and the drawings
X4-2	Procurement of materials that do not meet technical specifications
X4-3	Poor work quality due to failure to follow instructions from the site supervisor
X4-4	Inadequate project security measures
X4-5	Lack of awareness among workers regarding compliance with occupational safety and health regulations
X4-6	There is a shortage of workers
X4-7	Coordination between the owner, consultants, and contractors is not going well
X4-8	Delays in project completion
X4-9	Differences in the calculation of the volume of work
X5	**Technical Risks**
X5-1	Design and technical changes to the work resulting from adjustments to on-site conditions
X5-2	Differences between the measured results regarding the quality and quantity of work and the actual conditions on-site
X5-3	Difficulties in moving heavy equipment due to the project site’s proximity to highway traffic
X5-4	A change to a work item that causes a delay in the execution of the work
X5-5	Disruption of underground utilities such as existing pipelines that hinder the execution of excavation work.
X6	**Risk Management**
X6-1	Delays in design preparation and approval
X6-2	Discrepancies between the quantities of work in the BOQ and the conditions on-site
X6-3	The use of inappropriate implementation methods
X7	**Environmental/Social Risks**
X7-1	Traffic congestion during the course of the work
X7-2	Social issues have arisen in workplaces located near residential areas
X7-3	damage to private property owned by residents living near the project
X7-4	Air pollution during the course of the work
X8	**Economic Risks**
X8-1	An increase in the price of building materials during the construction period
X8-2	Any increase in fuel prices during the project period that could affect project performance
X9	**Criminal Risk**
X9-1	The loss of materials and work equipment during the course of the project

Sources: Test Result 2026

3.3 Risk Analysis

Based on the results of the Severity Index (SI) probability calculation of 46 respondents and impact assessment by the researcher, the risk level (R = P × I) was obtained for 32 risk variables grouped into 9 risk factors. Table 2 presents the results of the risk level analysis of all variables.

Tabel 2. Riks Level Analysis

Code	P	I	R	Risk Level
X1-1	3	3	9	Medium
X1-2	3	2	6	Medium
X1-3	3	3	9	Medium
X2-1	5	4	20	High
X3-1	5	4	20	High
X3-2	3	3	9	Medium
X3-3	3	4	12	Medium
X3-4	4	3	12	Medium
X4-1	4	4	16	High
X4-2	3	3	9	Medium
X4-3	3	4	12	Medium
X4-4	4	5	20	High
X4-5	3	4	12	Medium
X4-6	4	3	12	Medium
X4-7	3	5	15	Medium
X4-8	3	5	15	Medium
X4-9	4	3	12	Medium
X5-1	4	4	16	High
X5-2	3	2	6	Medium
X5-3	5	5	25	High

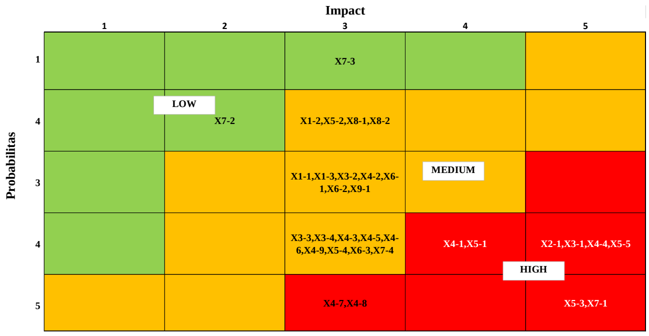
X5-4	4	3	12	Medium
X5-5	5	4	20	High
X6-1	3	3	9	Medium
X6-2	3	3	9	Medium
X6-3	3	4	12	Medium
X7-1	5	5	25	High
X7-2	4	1	4	Low
X7-3	3	1	3	Low
X7-4	4	3	12	Medium
X8-1	3	2	6	Medium
X8-2	3	2	6	Medium
X9-1	3	3	9	Medium

Sources: Test Result 2026

3.4 Risk Evaluation

Risk evaluation is carried out by mapping the level of risk into a probability-impact matrix to determine the significance of the risk and the priority of treatment. Based on SNI IEC/ISO 31010:2016 and Ministerial Regulation of PUPR Number 10 of 2021, the probability-impact matrix is used to classify risks into three categories: low risk (value 1–5, green), medium risk (value 6–12, yellow), and high risk (value 15–25, red) [5]. Figure 1 shows the risk mapping matrix of the research results.

Figure.1 Risk Level Matrix Based on Probability and Impact



Source: Minister of Public Works and Housing Regulation No. 10 of 2021

The results of the risk evaluation showed that 10 variables (31.25%) were in the high risk category (red zone) so they needed immediate treatment. The variables X5-3 and X7-1 obtained the highest risk values (R=25), indicating an almost certain probability of occurrence and a significant impact on the achievement of project objectives. This condition is in line with field findings, namely traffic congestion and difficulty in mobilizing heavy equipment as the main obstacles to project implementation. A total of 20 variables (62.5%) included medium risk (yellow zone) that required control and monitoring, while 2 variables (6.25%) were in the low risk category (green zone) and were adequately monitored periodically. Priority management refers to the ALARP principle, namely high risk is addressed through avoidance, reduction, or diversion strategies, while medium and low risk are managed through risk reduction and routine monitoring.

3.5 Evaluation of Risk Management Implementation Based on ISO 31000:2018

The evaluation of the implementation of risk management was carried out by comparing actual practices in the field with the ISO 31000:2018 risk management framework which includes 6 process components. Table 4 presents the results of the evaluation based on interviews with 3 key informants.

Tabel 3. Interview Result Based on ISO 31000:2018

ISO 31000 Components	Application Description
Communication and Consultation	Risk communication is carried out through weekly coordination meetings, but does not have a specific scheduled agenda for risk discussion. Communication is reactive to problems that arise.
Scope, Context and Criteria	The context of the project has been identified through the RKK and IBPRP documents. Risk criteria are established based on previous project experience.
Risk Assessment	Risk identification is carried out through IBPRP and RKK at the planning stage. However, the risks of underground utilities are not optimally identified.
Risk Assessment (Analysis)	Risk analysis is carried out qualitatively based on the experience of the project team. No quantitative methods such as probability-impact are systematically used
Risk Assessment (Evaluation)	Risk evaluation is carried out based on subjective considerations of project management. There is no formal risk matrix that is updated regularly.
Risk Treatment	Risk management is dominated by risk reduction strategies through the addition of manpower, extension of working hours, and method adjustments. No risk avoidance or risk transfer strategy is applied even though there is a risk with a value of R = 25.
Monitoring and Review	Monitoring is carried out through weekly reports and field inspections. However, the risk list is not updated during the implementation of the project, so it does not accommodate the dynamic principles of ISO 31000:2018.
Recording and Reporting	Risk documentation is available in the form of IBPRP, RKK, and weekly reports. However, there is no risk

	register that is integrated as a living document.

Sources: Test Result 2026

The results of the evaluation show that the implementation of risk management in general has been carried out but is not fully in accordance with the ISO 31000:2018 framework. There are three critical gaps identified. First, risk communication does not have a scheduled agenda and is reactive to problems that arise, rather than systematic and proactive. Second, the risk list is not updated during the implementation of the project, which violates the dynamic principles of ISO 31000:2018 which require responsiveness to change. Third, risk management relies only on risk reduction strategies without the implementation of risk avoidance or risk diversion, even for the highest value risks (R = 25). These three gaps are closely related to the realization of high-risk variables and schedule delays of 7 days

3.5 Cost Analysis of Construction Safety Management System (SMKK)

Based on the calculation of SMKK costs according to the Minister of PUPR Regulation Number 10 of 2021, the total cost of SMKK was obtained of IDR 223,414,694.00 or 0.73% of the project contract value of IDR 30,750,595,267.42. Table 4 presents a recapitulation of the costs of the 9 components of the SMKK.

Tabel 4. SMKK Implementation Budget Plan

No	Cost Component	Total Price	Present ase (%)
1	Preparation of SMKK implementation documents	4.200.000,00	1,88
2	Socialization, promotion, and training of K3	18.122.884,00	8,11
3	Work Protective Equipment (APK) and Personal Protective Equipment (PPE)	18.513.112,00	8,29
4	Construction safety insurance and licensing	30.750.595,00	13,76
5	Construction safety personnel	108.000.000,00	48,34
6	Medical equipment facilities	1.627.990,00	0,73
7	Traffic signs and fixtures	35.575.113,00	15,92
8	Consultation with a construction safety expert	4.000.000,00	1,79
9	Activities and equipment related to K3 risk control	2.625.000,00	1,17
	TOTAL	223.414.694,00	100,00

Sources: Test Result 2026

The smallest cost component is the medical equipment facility (0.73%), which consists of a P3K box and its contents according to the Regulation of the Minister of Manpower and Transmigration Number PER.15/MEN/VIII/2008. The percentage of the total cost of SMKK of 0.73% is still below the general provision which states that the cost of K3 implementation and construction safety is around <1.0% of the value of the work [11]. This indicates that the allocation of safety costs on this project is still at a minimum, so it is necessary to consider increasing the allocation for risks with a high level of complexity.

4. CONCLUSION

Conclusion of this study:

1. The actual condition of the project shows three main risks causing delays, which are traffic congestion, underground utility disruptions (PDAM pipelines), and unpredictable weather, with the highest cumulative progress deviation of −29.468%.
2. There are 32 risk variables analyzed : 10 high risk, 20 medium risk, and 2 low risk. The highest risk is dominated by traffic, weather, and labor aspects.
3. The implementation of risk management has followed the stages of ISO 31000:2018, but it is not optimal because communication of risk is not comprehensive, the risk list has not been updated regularly, and handling is still focused on risk reduction.
4. The cost of implementing SMKK is IDR 223,414,694.00 or 0.73% of the contract value, with the largest allocation to construction safety personnel.

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