Quest Journals
Journal of Architecture and Civil Engineering
Volume 11 ~ Issue 1 (January 2026) pp: 40-49
ISSN(Online): 2321-8193
www.questjournals.org

Research Paper

Risk Management Analysis of Check Dam Construction on Perhutani Land with AS/NZS 4360:2004 (A Case Study of Gamping Check Dam on Tulungagung Regency – Indonesia)

Novia Dwi Fatmawati[1], Nusa Sebayang[2], Erni Yulianti[3*]
[1,2,3] (Post Graduate Program of Civil Engineering, National Institute of Technology, Malang, Indonesia)
Corresponding Author: Erni Yulianti

ABSTRACT : *A Check Dam construction is a way to mitigate land erosion and flooding in Campurdarat District of Tulungagung Regency. Unfortunately, its implementation on Perhutani land experiencing multidimensional risks which include technical, legal, social, and environmental aspects. This study aims to analyze the risk management applied in Gamping Check Dam construction using the AS/NZS 4360:2004 standard.*
The selected research method in this study was qualitative descriptive method with collected data obtained through questionnaries and interviews from 23 respondents. Instrument validity and reliability tests conducted by SPSS version 27 and risk level analysis was conducted by Severity Index method and a Probability-Impact Matrix based on AS/NZS 4360:2004 standard.
Research results were able to identify 20 risk factors covering technical, human resources, financial, material, safety, environmental and legal aspects. From the Probability-Impact Matrix, there are 3 risks found in a very high risk category, 1 risk in a high risk category and 16 risks in moderate category. Risks with a very high level include unpredictable weather, river overflow, and delay or lateness in land permit process,each risk have risk value of 16, whereas risk of difficult road access is in high level category with risk value of 12. These risks have potentiality to cause delay in work implementation and able to increase the project costs when they are not managed in a systematical way. This study also provides a practical contribution in form of a structure and applicable risk management model for Check Dam Construction project on Perhutani Land.
KEYWORDS: *Risk Management, Check Dam Construction, AS/NZS 4360:2004, Project Cost, Quantitative Descriptive.*

R*eceived 08 Jan., 2026;* ***R****evised 18 Jan., 2026;* ***A****ccepted 20 Jan., 2026 © The author(s) 2026.*
P*ublished with open access at* ***www.questjournas.org***

I. INTRODUCTION

Gamping check dam construction utilizes forest land owned by *Perhutani* in Gamping Village, Campurdarat District of Tulungagung Regency where the length of land area is 820 m^2, sediment storage capacity of 296.3 m^3, 7.8 meter in building height and 118.7 m^2 of a flood area. Public Works and Spatial Planning Agency (*Dinas Pekerjaan Umum dan Penataan Ruang)* of Tulungagung Regency are the responsible unit that obliged to carry out the management, environmental monitoring and land permits to the land owner **(***Perhutani).*

Majority of research studies on check dams in Indonesia still dominated by theme of technical approaches such as design study, structural stability and sediment retention capacity where non-technical dimensions including policy and social aspects tend to be negligible. In addition, studies about land conflicts in Java have dominant focus on agrarian and plantation sectors rather than public infrastructure sector, resulting a limited discussion in area of public acceptance to water conservation projects. Further, although an international risk management standard like AS/NZS 4360:2004 is applied to large-scale projects as example in concrete bridge construction, its application to small infrastructure projects such as check dam construction is sparse. This situation highlights a research gap intended to integrate multidimensional aspects of technical, legal, and social risks analysis for the specific context of check dam construction in *Perhutani* forest land areas. [1,2]

On the basis of the actual condition, this study aims to conduct a risk management analysis to Check Dam construction on *Perhutani* land with AS/NZS 4360:2004 in a form of Case Study of Gamping Check Dam in Tulungagung Regency. This study proposes application of AS/NZS 4360:2004 to develop a structured risk management framework as follows: (1) How to identify risk impacts in Gamping Check Dam construction on *Perhutani* land as assessed by Tulungagung Regency Government Unit? (2) What is the risk level of Gamping

Check Dam Construction when it assessed through a Probability-Impact Matrix of AS/NSZ 4360:2004? (3) What is the effective mitigation strategy for reducing potential risks and ensuring project sustainability aspect?

II. LITERATURE REVIEW

2.1. Check Dam

A check dam is a sediment control structure designed to reduce flow energy and traps any entrained material aimed to minimize erosion risk. Yet, improper or unsuitable design and construction can lead to structural failure and additional environmental damage. Therefore, an accurate planning supported by topographic, geotechnical, hydrological and hydraulic analyses becomes critical act to ensure the building effectiveness. [3,4]

2.2. Risk Management in Infrasctructure Project

Risk management in infrastructure projects involves structured processes of identifying, analyzing, responding to, and monitoring risks throughout the project lifecycle. For small-scale projects in Indonesia, project implementation often be limited by short supply of human resources, budget constraints and weak external risk control which highlighting urgency for locally tailored risk management model. These issues are very relevant with check dam projects where permit process and local community engagement become critical risk factors. Thus, it is crucial to do a continuous risk monitoring in particular for water retention dams that vulnerable to extreme weather condition also prone to experience regulatory constraints. [5,6]

2.3. Standard of AS/NZS 4360:2004

AS/NZS 4360:2004 is a generic risk management framework developed in Australia and New Zealand with emphasis on integration of risk culture into the organization practices and addressing both potential losses and gains [7]. In comparison with ISO 31000, this standard considered more pragmatic and adaptable to local project contexts. These characteristics make this standard relevant for public infrastructure public like Check Dam where certain risks of technical, regulatory and social are interacting during the project. Therefore, AS/NZS 4360:2004 was adopted in this study as an analytical framework to examine the multidimensional risk management applied in Check Dam project.

2.4. Risk Management Process

According to Sahabuddin, implementation of risk management offers plentiful benefits for decision-making process, including addressing complex problems, simplifying the cost estimation, and providing a rational and intuitive basis for the project. This approach enables decision-makers to have better preparation for posing risks and uncertainty, also identify information needed to create effective strategy in resolving problems. Furthermore, risk management encourages the uses of systematic and logical methods in formulating problems and evaluating alternative solutions. [8]

Standard of AS/NZS 4360:2004 defines risk management as a structured method for minimizing losses and supporting decision-making. This framework encompasses establishing context, identifying, analyzing, and evaluating risks as well as monitoring and communicating risks in entire activities. [9]

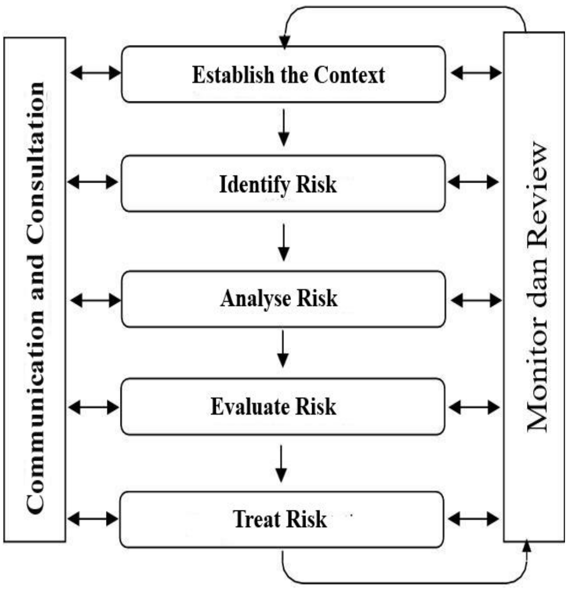

Figure 1. A risk management flowchart. [8]

III. RESEARCH METHOD

3.1. Data Collection

This study used primary data through identification of social interactions between local communities regarding project of Check Dam construction, observation of construction process, quantitative questionnaire-based research, and planning data documents. In addition, secondary data was also obtained through literature reviews of scientific journals related to risk management research which aimed to identify initial risks of a project.

3.2. Sample and Population of the Study

Population of this study consisted from individuals involved in Gamping Check Dam construction project in Tulungagung Regency, including the Water Resources Unit (SDA) of Public Works and Public Housing Agency (PUPR), planning consultant, implementing consultant, supervisory consultant, *Perhutani,* and academicians. Sample of the study was determined using Slovin Formula from total population of 30 individuals.

3.3. Reliability Test

According to Notoatmodjo in Wijayanto reliability is an indicator that reveals the level of trustworthiness or reliability of a measurement instrument. Through reliability testing, determination whether a measuring instrument able to produce consistent data when used repeatedly can be done. An instrument will be considered as reliable tool if it produces the same results even after multiple measurement are taken. In general, before conducting a reliability test, a validity test became the first testing to do to ensure the data used verified as valid. If tested data is invalid then no need to conduct a reliability testing. [10]

Reliability test aims to assess the farthest extent of an instrument is able to provide a consistent result when re-measured under the same conditions. Reliability testing is measured using internal consistency techniques by specific calculation of Cronbach's Alpha coefficient. A Cronbach's Alpha value $\geq$ 0.70 considered as indication of acceptable reliability level in social and engineering research. Instruments with high alpha values indicate the questionnaire items have a consistent relationship in measuring one same construct. The ultimate goal of this test is to determine whether the entire questionnaire has good internal consistency to be used as a measurement tool in scientific research or not.

IV. RESULT AND DISCUSSION

4.1. Reliability Test

A reliability test is an index indicates reliability or trustworthiness level of a measuring instrument. This test able to determine instrument's consistency (whether the measuring instrument produces consistent results when measurement is taken repeatedly or not) and an instrument is considered as reliable when it produces consistent data in each taken measurement.

Reliability test for this study was conducted using Cronbach's Alpha method aided by SPSS program version 27. An instrument is declared reliable if the calculated r-value or Cronbach's Alpha value exceeds 0.6. The result of reliability test for variables of risk and impact frequency level are presented in the following table (Table 1).

Table 1. The reliability test of probability and risk impact level

	Cronbach's Alpha	**Description**
Risk Probability	0,936	Reliable
Risk Impact	0,953	Reliable

Table 1 described the Cronbach's Alpha value for the risk probability instrument is 0.936, since the value is greater than 0.6 then the instrument can be declared as reliable. Meanwhile, the Cronbach's Alpha value for risk impact instrument is 0.953 which greater than 0.6, therefore the instrument also can be declared as reliable.

4.2. Risk Analysis

Each risk variable assessed by using a scale of probability and impact/consequence, and it will be used to determine the risk level afterwards. Based on respondent data in this study, it is necessary to combine assessment results with Severity Index (SI) method and presented as percentage (%) to provide a frequency and impact assessment for each risk variable. This method serves as a representative scale for the probability and impact values given by respondents of this study. Meanwhile, the method for conducting this test employs the 2-2 and 2-3 equations is presented in the following explanation:

$$\mathbf{SI}(\boldsymbol{p}) = \frac{\sum_{i=1}^{5} \alpha_i x_i}{5\sum_{i=1}^{5} x_i} x100\% \quad (2\text{-}2)$$

$$\mathbf{SI}(\mathbf{i}) = \frac{\sum_{i=1}^{5} \alpha_i x_i}{5\sum_{i=1}^{5} x_i} x100\% \quad (2,3)$$

Where:
SI(p) : Severity index of Probability
SI(I) : Severity index of Impact
ai : Valuation Constant
xi : Frequency of Respondent
i : 1, 2, 3, 4, 5........., n

x1, x2, x3, x4, x5 : responses of respondent frequency
x1 : Respondent Frequency of "Rare/Insignificant", then a1 = 1
x2 : Respondent Frequency of " Sometimes/Small" then a2 = 2
x3 : Respondent Frequency of "Frequent/Moderate" then a3 = 3
x4 : Respondent Frequency of "Often/Heavy" then a4 = 4
x5 : Respondent Frequency of "Almost definite to happen/Catastrophic" then a5=5

Example of Severity Index (SI) calculation for Probability Assessment:

SI of Equipment Damage (P1) variable:

$$\mathbf{SI}(\boldsymbol{p}) = \frac{(1x5) + (2x10) + (3x4) + (4x4) + (5x0)}{5x23} x100\%$$

$$\mathbf{SI}(\boldsymbol{p}) = \frac{5 + 20 + 12 + 16 + 0}{115} x100\%$$

$$\mathbf{SI}(\boldsymbol{p}) = \frac{53}{115} x100\%$$

$$\mathbf{SI}(\boldsymbol{p}) = 46{,}1\%$$

Result calculation with Severity Index (SI) method on the next impact assessment variables is presented in the following table (Table 2).

Table 2. Impact assessment by severity index (SI) method

No	Risk Factor	Level of Probability (P)					Amount	*Severity Index* (SI)
		1	2	3	4	5		
1	Equipment damage	5	10	4	4	0	23	46,1
2	Incompatible technical specifications	3	9	7	4	0	23	50,4
3	Design changes	3	10	5	2	3	23	53,0
4	Difficulty during excavation	8	4	10	1	0	23	43,5
5	Reduced productivity of workers	9	4	8	2	0	23	42,6
6	Insufficient or lack of workers	7	8	4	2	2	23	46,1
7	Material price increases	7	5	8	2	1	23	47,0
8	Error in cost estimation	9	7	5	2	0	23	40,0
9	Operational cost increases	10	6	5	2	0	23	39,1
10	Difficult road access	1	6	10	4	2	23	60,0
11	Material delays	6	7	8	2	0	23	45,2
12	Material quality	6	10	6	1	0	23	41,7
13	Material loss	14	5	3	1	0	23	32,2
14	Lack of work sign	5	9	6	3	0	23	46,1
15	Worker's negligence/workplace accident	13	5	4	1	0	23	33,9
16	Incomplete k3 equipment	5	7	6	5	0	23	49,6
17	Unpredictable weather (rain)	2	1	9	6	5	23	69,6
18	River overflows	2	4	10	3	4	23	62,6
19	Community conflict	5	8	8	2	0	23	46,1

No	Risk Factor	Level of Probability (P)					Amount	*Severity Index* (SI)
		1	2	3	4	5		
20	Delay/lateness in land permit process	2	4	0	14	3	23	70,4

After Severity Index (SI) value from table 2 had been obtained, the following conversions performed according to the Impact scale (I)

- Very Small 0 < SI < 20 = Scale 1
- Small 20 < SI < 40 = Scale 2
- Moderate 40 < SI < 60 = Scale 3
- Large 60 < SI < 80 = Scale 4
- Very Large 80 < SI < 100 = Scale 5

Then, detailed impact scale is presented in the following table (Table 3).

Table 3. Recapitulation of risk probability and severity index conversion calculation

No	Risk Factor	P	*Severity Index* (SI) (%)	Scale
1	Equipment damage	1	46,1	3
2	Incompatible technical specifications	2	50,4	3
3	Design changes	3	53,0	3
4	Difficulty during excavation	4	43,5	3
5	Reduced productivity of workers	5	42,6	3
6	Insufficient or lack of workers	6	46,1	3
7	Material price increases	7	47,0	3
8	Error in cost estimation	8	40,0	2
9	Operational cost increases	9	39,1	2
10	Difficult road access	10	60,0	3
11	Material delays	11	45,2	3
12	Material quality	12	41,7	3
13	Material loss	13	32,2	2
14	Lack of work sign	14	46,1	3
15	Worker's negligence/workplace accident	15	33,9	2
16	Incomplete K3 equipment	16	49,6	3
17	Unpredictable weather (rain)	17	69,6	4
18	River overflows	18	62,6	4
19	Community conflict	19	46,1	3
20	Delay/lateness in land permit process	20	70,4	4

Table 3 explains conversion calculation process such as for first risk factor (Equipment damage with risk code P1) has a Severity Index (SI) value of 46.1 %, where this value falls in 'sometimes' category (40 < SI < 60) means it is included into Scale 3. Then, the rest or subsequent risk factors can follow the above pattern.

Example of Severity Index (SI) calculation for probability:
SI of Equipment Damage Variable (P1)

$$\mathbf{SI}(\boldsymbol{p}) = \frac{(1x3) + (2x7) + (3x5) + (4x5) + (5x3)}{5x23} x100\%$$

$$\textbf{SI}(\boldsymbol{p}) = \frac{3 + 14 + 15 + 20 + 15}{115} x100\%$$

$$\textbf{SI}(\boldsymbol{p}) = \frac{67}{115} x100\%$$

$$\textbf{SI}(\boldsymbol{p}) = 58{,}3\%$$

Result calculation using Severity Index (SI) method on Impact Assessment Variables is presented in the following table (Table 4).

Table 4. Impact assessment by severity index (SI) method

No	Risk Factor	Impact Level (I)					Amount	*Severity Index* (SI)
		1	2	3	4	5		
1	Equipment damage	3	7	5	5	3	23	58,3
2	Incompatible technical specifications	3	6	8	4	2	23	56,5
3	Design changes	3	7	8	2	3	23	55,7
4	Difficulty during excavation	4	9	9	1	0	23	46,1
5	Reduced productivity of workers	5	5	4	8	1	23	55,7
6	Insufficient or lack of workers	4	8	4	5	2	23	53,9
7	Material price increases	7	7	7	1	1	23	44,3
8	Error in cost estimation	7	8	6	1	1	23	43,5
9	Operational cost increases	9	6	6	1	1	23	41,7
10	Difficult road access	1	5	9	6	2	23	62,6
11	Material delays	4	9	6	1	3	23	51,3
12	Material quality	5	7	7	4	0	23	48,7
13	Material loss	11	3	5	4	0	23	41,7
14	Lack of work sign	6	7	5	4	1	23	48,7
15	Worker’s negligence /workplace accident	10	4	4	4	1	23	44,3
16	Incomplete K3 equipment	5	8	5	4	1	23	49,6
17	Unpredictable weather (rain)	2	1	9	7	4	23	68,7
18	River overflows	2	3	9	4	5	23	66,1
19	Community conflict	4	5	6	4	4	23	59,1
20	Delay/lateness in land permit process	2	3	1	9	8	23	75,7

After Severity Index (SI) values have been obtained and listed in Table 4, the following conversion is performed according to the impact scale (I)

- Very Small 0 < SI < 20 = Scale 1
- Small 20 < SI < 40 = Scale 2
- Moderate 40 < SI < 60 = Scale 3
- Large 60 < SI < 80 = Scale 4
- Very Large 80 < SI < 100 = Scale 5

The detailed impact scale is presented in the following table (Table 5).

Table 5. Recapitulation of risk probability and severity index conversion calculation

No	Risk Factor	P	*Severity Index* (SI) (%)	SCALE
1	Equipment damage	1	58,3	3
2	Incompatible technical specifications	2	56,5	3
3	Design changes	3	55,7	3
4	Difficulty during excavation	4	46,1	3
5	Reduced productivity of workers	5	55,7	3
6	Insufficient or lack of workers	6	53,9	3
7	Material price increases	7	44,3	3
8	Error in cost estimation	8	43,5	3
9	Operational cost increases	9	41,7	3
10	Difficult road access	10	62,6	4
11	Material delays	11	51,3	3
12	Material quality	12	48,7	3
13	Material loss	13	41,7	3
14	Lack of work sign	14	48,7	3
15	Worker's negligence /workplace accident	15	44,3	3
16	Incomplete K3 equipment	16	49,6	3
17	Unpredictable weather (rain)	17	68,7	4
18	River overflows	18	66,1	4
19	Community conflict	19	59,1	3
20	Delay/lateness in land permit process	20	75,7	4

Table 5 explains conversion calculation process where the example is the first factor (Equipment damage with risk code of P1) has a Severity Index (SI) value of 58.3% and falls in 'moderate' category (40 < SI < 60) and included into Scale 3. For the rest of subsequent risk factors can follow the above pattern.

From table 3 and table 5, the risk level can be obtained using Probability and Impact Scale multiplication formula according to AZ/NZS 4360:2004 as stated in formula 2-1 (Chapter 2):

Risk (R) = Probability (P) x Consequence (C) .... *(1)*

Where:
R : risk level
P : probability
C : impact

Therefore, risk level for Equipment Damage (P1) variable is:
Risk level = 3 x 3 = 9
Meanwhile, the subsequent variables are presented in the following table (Table 6).

Table 6. Risk level of each variable

No	Risk Factor	P	Probability (P)		Impact (I)		Risk Level
			SI	Scale	SI	Scale	
1	Equipment damage	1	46,1	3	58,3	3	9

2	Incompatible technical specifications	2	50,4	3	56,5	3	9
3	Design changes	3	53,0	3	55,7	3	9
4	Difficulty during excavation	4	43,5	3	46,1	3	9
5	Reduced productivity of workers	5	42,6	3	55,7	3	9
6	Insufficient or lack of workers	6	46,1	3	53,9	3	9
7	Material price increases	7	47,0	3	44,3	3	9
8	Error in cost estimation	8	40,0	2	43,5	3	6
9	Operational cost increases	9	39,1	2	41,7	3	6
10	Difficult road access	10	60,0	3	62,6	4	12
11	Material delays	11	45,2	3	51,3	3	9
12	Material quality	12	41,7	3	48,7	3	9
13	Material loss	13	32,2	2	41,7	3	6
14	Lack of work sign	14	46,1	3	48,7	3	9
15	Worker's negligence /workplace accident	15	33,9	2	44,3	3	6
16	Incomplete K3 equipment	16	49,6	3	49,6	3	9
17	Unpredictable weather (rain)	17	69,6	4	68,7	4	16
18	River overflows	18	62,6	4	66,1	4	16
19	Community conflict	19	46,1	3	59,1	3	9
20	Delay/lateness in land permit process	20	70,4	4	75,7	4	16

Table 6 explains the calculation of risk level as shown from the first risk factor (Equipment damage with risk code P1) has probability scale of 3 and an impact scale of 3, so the risk level value is 9 (3 x 3), while for the rest of risk factors can follow the above pattern.

4.3. Risk Mitigation

Risk mitigation aims to improve control over risk occurrences during activity of implementation process, and based on risk analysis in this study all risks that require further investigation or handling to prevent significant impacts can be identified. Of 20 risk variables, there are 3 variables categorized as very high-risk level, 1 variable categorized as high risk level, and 16 variables categorized as moderate risk level. In handling variables with moderate risk level, the parties involved (project owner or PUPR Agency, goods and service providers /contractors and consultants) only have to make simple coordination in monitoring and controlling these risks. Meanwhile, for risk categories that require mitigation are those risks that fell into high and very high-risk categories. In the mitigation process, interviews are conducted with those interest holders and responsible parties according to the risk allocation along with finding references from previous research.

Difficult road access becomes a high-risk factor during Gamping Check Dam construction project in Tulungagung Regency due to far site construction from the local government access roads which necessitates equipment and material removal and retrieval spot by clearing the access roads. Aside from it, mountainous topography also presents challenges for this project.

Meanwhile, variables categorized as very high risk are include unpredictable weather (rain), river overflows, and delay or lateness in land permit process. Since the building situated in transversal/horizontal position to the river then the weather condition especially during the rainy season poses a particular risk. The river accommodates mountain flows, type of flows which difficult to predict due to imbalanced forest ecosystem of Gamping Mountain since these areas are having land conversion. Moreover, a lengthy permitting process with land owner (*Perhutani*) makes the construction process prone to be delayed.

Given high risk factors inherent within Gamping Check Dam construction project, a mitigation strategy is required to handle high and very high risk factors of the project. As a follow up to this strategy, a Focus Group Discussion (FDG) was conducted involving stakeholders, including the Public Works Agency (PPK, PPTK, and Field Supervisors), Supervising Consultants and Service Providers.

In general, control of construction activities of the Gamping Check Dam project in Tulungagung Regency is presented in the following table (Table 7).

Table 7. Technical data of Gamping Check Dam Construction Project

No	Risk Factor	Code	Risk Value	Risk Category	Control
1	Unpredictable weather (rain)	P17	16	Very High	Arrange flexible work schedules, provide material protection in the field, and prepare contingency plans when heavy rainfall occurs.
2	River overflows	P18	16	Very High	Conduct monitoring regular to river discharge, add temporary protection in work areas, and stop high-risk activities when potential for flooding increases.
3	Delay or lateness in land permits process	P20	16	Very High	Conduct intensive communication with related agencies, complete work documents earlier, and accelerate administrative coordination to minimize time constraints.
4	Difficult road access	P10	12	High	Make temporary repairs to the location route, arrange a more efficient material distribution pattern, and use appropriate vehicles for terrain conditions.

Table 7. reveals that cooperative act between all parties in engaging coordination and synergize efforts also increase awareness or be vigilant to any working risks in the project is an important step for the implementation and smooth running of construction activities in this development project.

V. CONCLUTION

There are several conclusions based on the result of qualitative and quantitative data analysis of this study which will be listed below.

1. Gamping Check Dam Construction Project on *Perhutani* land faces so many internal risks since the beginning phase from technical, human resource, financial, material, safety, environmental and legal aspects. These risks carry potential to cause construction delays, cost overrun, reduced quality and productivity, also increased the occupational safety risks. These factual risks demonstrate high complexity of check dam construction in forest areas which requires a systemic risk management from the early/initial phase of the project.
2. Based on the Probability-Impact Matrix assessment of AS/NZS 4360:2004, there are 3 risks identified as very high risk, 1 risk identified as high risk, and 16 risks identified as moderate risks where 4 priority risks requiring mitigation as stated to be: unpredictable weather (rain), river overflows, delay in land permit process (each with risk level of 16) and difficult road access with risk level of 12. These risks have significant potential to halt the construction activities, damage materials, and endanger workers' safety. While the remaining risks are categorized at moderate to low risk levels and only requires ongoing monitoring activity to maintain the project work performance.
3. The selected mitigation strategy implemented for priority risks have proven effective based on the field observation and implementation evaluation. The mitigation efforts are including improving temporary access, using alternative material distribution routes, work schedule adjustment to accommodate extreme weather, installing temporary embankments, increasing water discharge monitoring and intensive coordination regarding land permits. The implementation of these mitigations is able to improve smoothness operational, reduces potential delays, and strengthens team's readiness to face changes in field condition.

REFERENCES

[1]. Suhudi, & Alexander, D., (2024). Studi perencanaan check dam pada sungai nambaan sebagai penampung sedimen di Kecamatan Ngantang, Kabupaten Malang. *Journal of Industrial Engineering & Technology Innovation*, **2**(*1*); pp. 10–18. DOI: https://doi.org/10.61105/jieti.v2i1.84

[2]. Hartono, W., Handayani, D., & Sabrina, F., (2024). "Analisis manajemen risiko dampak kecelakaan kerja pada proyek konstruksi jembatan beton dengan standar AS/NZS 4360:2004". Matriks Teknik Sipil, **11**(*4*); pp. 384. DOI: 10.20961/mateksi.v11i4.76711

[3]. Sulistiyono, H., (2023). "Pengembangan sumber daya air di bidang teknik sipil". Lombok: CV. Putra Rinjani. ISBN 978-623-5297-30-9.

[4]. Oktaviariyadi, N., Dermawan, V., & Saputra, A.W.W., (2023). Study planning of check dam as sediment controller at Sumbersari Universitas Brawijaya Forest Area. *Jurnal Teknik Pengairan: Journal of Water Resources Engineering*, **14**(*2*); pp. 185-191. DOI: https://doi.org/10.21776/ub.pengairan.2023.014.02.10

[5]. Tinambunan, Y., (2024). Manajemen risiko dalam proyek konstruksi: evaluasi dan pengembangan model. Yogyakarta: Jurnal Ekonomi, Akuntasi dan Manajemen Indonesia. *Jurnal Ekonomi, Akuntasi Dan Manajemen Indonesia (JEAMI)*, **3**(*1*); pp. 10–19. DOI: https://doi.org/10.58471/jeami.v3i01.599
[6]. Tserng, H.P., Liu, J.Y., & Huang, S.W., (2021). “Framework manajemen risiko konstruksi: Perencanaan, identifikasi, analisis, respons, dan kontrol”. Taipei: National Taiwan University Press.
[7]. Cooper, D., (2004). The Australian and New Zealand standard on risk management, As/Nzs 4360: 2004. Tutorial Notes: Broadleaf Capital International Pty Ltd,
[8]. Sahabuddin., (2023). Analisis manajemen risiko terhadap aspek K3 pada proyek flowline and facilities construction support services Pertamina Hulu Sanga-Sanga, [Thesis, Institut Teknologi Nasional, Malang]. URI: http://eprints.itn.ac.id/id/eprint/10868
[9]. Standards Australia & Standards New Zealand., (2004). Risk management: Principles and guidelines (AS/NZS 4360:2004). SAI Global.
[10]. Wijayanto, K., (2023). Manajemen risiko rehabilitasi Jalan Krebet – Gondanglegi Kabupaten Malang Hierarchy Proces, [Thesis, Institut Teknologi Nasional, Malang]. URI: http://eprints.itn.ac.id/id/eprint/13096