Identification of Dam Construction Risks to Job Owners: A Case Study of Dam Construction in East Java, Indonesia

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ABSTRACT
Approach to risk management, knowing the potential risks in realizing the construction of a dam construction on the side of the work owner in the East Java area. In the construction of a dam construction on the job owner has a potential effect on the success of the project. To achieve schedule, cost, quality, and service an effective risk management approach is carried out. The purpose of this research is to identify risks and provide a priority order of risks for the owner of the dam construction project in East Java that are most likely to occur to minimize the consequences arising from these risks. The identified risks will then be carried out by research using the Failure Mode and Effect Analysis (FMEA) method and then the highest risk priority sequence will be obtained so that the appropriate risk response can be determined in addressing these potential risks. It is hoped that in the next dam construction, the work owner will already know the biggest potential risks to minimize cost overruns, time, and quality.

KEYWORDS
Risk Identification, Risk Potential, Owner, FMEA

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1. Introduction
Construction projects have the primary objective of meeting functional requirements. The parties involved in construction are work owners, service providers, and work supervisors. The parties involved in construction have their respective roles and functions, in fulfilling the construction development activities will pose potential risks for each party.

Olsson in Serpella (2014) argues that there is uncertainty in everyday life in the organization of a project. There is a relationship between uncertainty to risk but risk is a measured uncertainty and uncertainty is a risk that cannot be measured (Hillson. 2011). To minimize the risks that will occur, it is necessary to make risk management which includes steps related to risk planning, risk identification, risk assessment, risk analysis, risk response, risk monitoring, and recording the risk management process (ISO, 2009).

The challenge of effective risk management is to convert as many unknown risks as possible into known risks through risk identification, assessment, and control, the purpose of risk management itself is to increase positive events and reduce negative events (threats) in the project according to Mulcahy in Hosny et al (2018).

Dam construction is a construction that functions for the wider community. Development has three (3) financing structures is a Owner, Contractor and supervisor, but in general dams in Indonesia use a budget from the government. Dam construction work owners are currently faced with various problems such as land acquisition, budget changes, efficiency in organization, changes in layout design, demonstrations by the community, social relations, incidents that occur, and so on. This situation creates problems that can hinder work and increase the difficulty in estimating costs and time accurately.

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To mitigate potential risks, good and appropriate risk management is needed to avoid risks that will possibly occur. If there is a risk that occurs, an organization that risks are quickly handled because it already knows what actions must be taken. The dam construction process in East Java began in 2019 and is planned to be completed in 2022 but has an additional multi-year contract until 2024. There are several problems in the construction so the construction of the dam becomes one of the high-risk projects. This will cause various risks that will affect the construction of the dam.

Owners of dam construction work in East Java have risks that must be identified so that work owners can know the high-risk factors that can affect dam construction.

The research conducted includes the identification, analysis, and rating of risks that will be potential risks for job owners during the construction period. The risks to be identified can be used in the construction of dams within the owner’s side of the work. This research has the advantage that it can be used as a reference source for construction companies, especially in the field of dam construction work so that it can be used to minimize the risks posed.

2. Methodology
The primary data collection method in the study was carried out with the results of questionnaires with several officials and supervisors who have authority on dam construction in East Java who were selected as respondents related to risk assessment. The flow chart in the following of research reparation as shown in Figure 1

Respondents in dam construction research in East Java are the owners of work involved in the implementation of dam construction projects. The identity of respondents was asked about their name, position, level of education, and work experience.
Risk management is defined as the process of risk factors. Risk management is an ongoing process on a project to manage the entire project turnaround. The work unit on a project needs a standard for handling potential events that can cause losses to the project. According to (Juran, 2018) states there are three factors or methods of failure that exist in FMEA, namely severity, occurrence, and detection. Risk data analysis using the Failure Mode and Effect Analysis (FMEA) method uses three criteria, namely severity, occurrence, and detection. Severity is the severity of the effect of a failure risk that will be perceived by the user, occurrence is the level of frequency of occurrence of each failure or cause of failure, and detection is the possibility that failure will be detected before affecting a risk.

Of these three criteria, the final result to determine high risk is the Risk Priority Number (RPN) value. The RPN value is obtained from Equation 1.

\[ RPN = \text{Severity} \times \text{Occurrence} \times \text{Detection} \]  

(1)

The risk value is wailed on the results of distributing questionnaires to the intended respondents. After calculating the RPN, the highest potential risk from dam construction was obtained from the owner of the work in East Java.

3. Results and Discussion

Risk identification is made using secondary data, namely data obtained from agencies in charge of dam construction work in East Java. Risk preparation based on Circular Letter of the Ministry of Public Works and Public Housing Number 04/SE/M/2021 concerning guidelines for the implementation of risk management. There are 7 (seven) risks, namely financial, reputation, fraud, legal, work accident, service, and performance risks. After obtaining the data, the potential risks are compiled, and make a preliminary questionnaire to ask whether the risk has high potential or not, so that the following risks are obtained as shown in Table 1.

<table>
<thead>
<tr>
<th>No</th>
<th>Types of risks</th>
<th>Failure Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Reputational Risk</td>
<td>Negative news on public</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Abandoned work</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>Overpay on a Progress</td>
</tr>
<tr>
<td>3</td>
<td>Performance Risk</td>
<td>Delay in Work progress</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>Rejection of the proposed budget increase plan</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>The investigation design study document is not in accordance with the conditions in the field</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>Problematic environmental impact analysis documents</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td>Delayed Auction process</td>
</tr>
<tr>
<td>8</td>
<td></td>
<td>Document Licensing Not in Accordance with the Proposal</td>
</tr>
<tr>
<td>9</td>
<td>Legal Risk</td>
<td>Communities Resist Land Acquisition</td>
</tr>
<tr>
<td>10</td>
<td></td>
<td>Differences in mechanisms with other ministries</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Delay in Submission &amp; Disbursement of Guarantees to the Bank by the provider</td>
</tr>
<tr>
<td>11</td>
<td>Service Risk</td>
<td>Natural Disasters (Landslides, Earthquakes)</td>
</tr>
<tr>
<td>12</td>
<td></td>
<td>Design Review</td>
</tr>
<tr>
<td>13</td>
<td></td>
<td>The dam cannot operate immediately</td>
</tr>
<tr>
<td>14</td>
<td>Budget Risk</td>
<td>Proposed Budget Increase Request</td>
</tr>
<tr>
<td>15</td>
<td></td>
<td>Refocusing the Budget</td>
</tr>
<tr>
<td>16</td>
<td>Risk of fraud</td>
<td>Execution of Work not in accordance with technical specifications</td>
</tr>
<tr>
<td>17</td>
<td></td>
<td>Unsuitable Experts</td>
</tr>
<tr>
<td>18</td>
<td>Risk of Work Accidents</td>
<td>Work accidents resulting in loss of life</td>
</tr>
</tbody>
</table>

Table 1 Risk Identification
After obtaining risk identification, a validation test will be carried out by using the IBS SPSS Statistic 25 application by comparing their $r_{count}$ and $r_{table}$ at a 95% confidence level. An item will be valid if it correlates significantly with a score at a 95% confidence level. The validity test is carried out with these 3 Log Person, Correlation, and Sig Tailed. Validity test is done by looking at the Pearson Correlation significance value. The results of the validity test as shown in Table 2.

**Table 2 - Output Pearson Correlation**

<table>
<thead>
<tr>
<th>Correlations</th>
<th>Total</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pearson Correlation</td>
<td>1</td>
<td>Valid</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>A2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pearson Correlation</td>
<td>1</td>
<td>Valid</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>B1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pearson Correlation</td>
<td>1</td>
<td>Valid</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>B2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pearson Correlation</td>
<td>1</td>
<td>Valid</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>B3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pearson Correlation</td>
<td>1</td>
<td>Valid</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>B4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pearson Correlation</td>
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<td>Valid</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>B5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pearson Correlation</td>
<td>1</td>
<td>Valid</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>B6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pearson Correlation</td>
<td>1</td>
<td>Valid</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>B7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pearson Correlation</td>
<td>1</td>
<td>Valid</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>B8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pearson Correlation</td>
<td>1</td>
<td>Valid</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>C1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pearson Correlation</td>
<td>1</td>
<td>Valid</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>C2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pearson Correlation</td>
<td>1</td>
<td>Valid</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>C3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pearson Correlation</td>
<td>1</td>
<td>Valid</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>D1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pearson Correlation</td>
<td>1</td>
<td>Valid</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>D2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pearson Correlation</td>
<td>1</td>
<td>Valid</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>D3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pearson Correlation</td>
<td>1</td>
<td>Valid</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>E1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pearson Correlation</td>
<td>1</td>
<td>Valid</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>E2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pearson Correlation</td>
<td>1</td>
<td>Valid</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>F1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pearson Correlation</td>
<td>1</td>
<td>Valid</td>
</tr>
</tbody>
</table>
The implementation of the reliability test is carried out after the validity test. The reliability test is expressed at values between 0-1. Reliability testing is done by comparing the value of Cronbach's alpha with the level / significant level used with criteria as follows: If the value of Cronbach’s alpha > a significant level, then the instrument is declared reliable. If the value of Cronbach’s alpha < a significant level, then the instrument is declared unreliable. The level of reliability based on Cronbach’s Alpha as shown in Table 3.

<table>
<thead>
<tr>
<th>Cronbach’s Alpha</th>
<th>Reliability Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00 s/d 0.20</td>
<td>Unreliable</td>
</tr>
<tr>
<td>0.20 s/d 0.40</td>
<td>Less Reliable</td>
</tr>
<tr>
<td>0.40 s/d 0.60</td>
<td>Quite Reliable</td>
</tr>
<tr>
<td>0.60 s/d 0.80</td>
<td>Reliable</td>
</tr>
<tr>
<td>0.80 s/d 1.00</td>
<td>Highly Reliable</td>
</tr>
</tbody>
</table>

Source: [4]

The next step is to test the reliability by comparing the value of Cronbach’s Alpha. The Cronbach’s Alpha value from statistics output obtained was 0.973 as shown in Table 4, by referring to Table 3 the interpretation is highly reliable.

<table>
<thead>
<tr>
<th>Reliability Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cronbach's Alpha</td>
</tr>
<tr>
<td>N of Items</td>
</tr>
<tr>
<td>0.973</td>
</tr>
<tr>
<td>21</td>
</tr>
</tbody>
</table>

The analysis of the FMEA method issues an output, namely the Risk Priority Number (RPN) which will be able to determine the priority risk for dam construction. RPN is obtained from three criteria, namely Severity (S), Occurrence (O), and Detection (D). The following is the average result of the questionnaire distributed to the intended respondents as shown in Table 5.

<table>
<thead>
<tr>
<th>Types of risks</th>
<th>Failure Mode</th>
<th>( \bar{x} ) (S)</th>
<th>( \bar{x} ) (O)</th>
<th>( \bar{x} ) (D)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reputational Risk</td>
<td>A.1 Negative news on public</td>
<td>3,000</td>
<td>3,000</td>
<td>2,000</td>
</tr>
<tr>
<td></td>
<td>A.2 Abandoned work</td>
<td>3,000</td>
<td>3,000</td>
<td>2,000</td>
</tr>
<tr>
<td>Performance Risk</td>
<td>B.1 Overpay on a Progress</td>
<td>3,000</td>
<td>3,000</td>
<td>2,000</td>
</tr>
<tr>
<td></td>
<td>B.2 Delay in Work progress</td>
<td>4,000</td>
<td>4,000</td>
<td>3,000</td>
</tr>
<tr>
<td></td>
<td>B.3 Rejection of the proposed budget increase plan</td>
<td>3,000</td>
<td>3,000</td>
<td>3,000</td>
</tr>
</tbody>
</table>
The calculation of Risk Priority Number (RPN) uses three variables, namely severity, occurrence, and detection. From the data obtained, an analysis of the calculation of the average value obtained on an indicator with the results as shown in Table 6.

### Table 6 - RPN Value Results

<table>
<thead>
<tr>
<th>Types of risks</th>
<th>Failure Mode</th>
<th>$\bar{x}$ (S)</th>
<th>$\bar{x}$ (O)</th>
<th>$\bar{x}$ (D)</th>
<th>RPN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reputational Risk</td>
<td>A.1 Negative news on public</td>
<td>3,000</td>
<td>3,000</td>
<td>2,000</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>A.2 Abandoned work</td>
<td>3,000</td>
<td>3,000</td>
<td>2,000</td>
<td>18</td>
</tr>
<tr>
<td>Performance Risk</td>
<td>B.1 Overpay on a Progress</td>
<td>3,000</td>
<td>3,000</td>
<td>2,000</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>B.2 Delay in Work progress</td>
<td>4,000</td>
<td>4,000</td>
<td>3,000</td>
<td>48</td>
</tr>
<tr>
<td></td>
<td>B.3 Rejection of the proposed budget increase plan</td>
<td>3,000</td>
<td>3,000</td>
<td>3,000</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td>B.4 The design investigation study document is not in accordance with the conditions in the field</td>
<td>4,000</td>
<td>4,000</td>
<td>3,000</td>
<td>48</td>
</tr>
</tbody>
</table>
Table 1: Risk Analysis - RPN Table

<table>
<thead>
<tr>
<th></th>
<th>Risk Category</th>
<th>Risk Description</th>
<th>RPN Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>B.5</td>
<td>Problematic environmental impact analysis documents</td>
<td></td>
<td>3,000 3,000 2,000 18</td>
</tr>
<tr>
<td>B.6</td>
<td>Delayed Auction process</td>
<td></td>
<td>3,000 3,000 2,000 18</td>
</tr>
<tr>
<td>B.7</td>
<td>Document Licensing Not in Accordance with the Proposal</td>
<td></td>
<td>3,000 3,000 3,000 27</td>
</tr>
<tr>
<td>B.8</td>
<td>Structural Failure</td>
<td></td>
<td>3,000 3,000 2,000 18</td>
</tr>
<tr>
<td>C.1</td>
<td>Communities Resist Land Acquisition</td>
<td></td>
<td>4,000 3,000 2,000 24</td>
</tr>
<tr>
<td>C.2</td>
<td>Differences in mechanisms with other ministries</td>
<td></td>
<td>3,000 3,000 3,000 27</td>
</tr>
<tr>
<td>C.3</td>
<td>Delay in Submission &amp; Disbursement of Guarantees to the Bank by the provider</td>
<td></td>
<td>3,000 2,000 2,000 12</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D.1</td>
<td>Natural Disasters (Landslides, Earthquakes)</td>
<td></td>
<td>3,000 3,000 3,000 27</td>
</tr>
<tr>
<td>D.2</td>
<td>Design Review</td>
<td></td>
<td>3,000 3,000 2,000 18</td>
</tr>
<tr>
<td>D.3</td>
<td>The dam cannot operate immediately</td>
<td></td>
<td>3,000 3,000 2,000 18</td>
</tr>
<tr>
<td>E.1</td>
<td>Proposed Budget Increase Request</td>
<td></td>
<td>3,000 3,000 3,000 27</td>
</tr>
<tr>
<td>E.2</td>
<td>Refocusing the Budget</td>
<td></td>
<td>4,000 3,000 3,000 36</td>
</tr>
<tr>
<td>F.1</td>
<td>Execution of Work not in accordance with technical specifications</td>
<td></td>
<td>3,000 3,000 2,000 18</td>
</tr>
<tr>
<td>F.2</td>
<td>Unsuitable Experts</td>
<td></td>
<td>3,000 3,000 2,000 18</td>
</tr>
<tr>
<td>G.1</td>
<td>Work accidents resulting in loss of life</td>
<td></td>
<td>3,000 3,000 2,000 18</td>
</tr>
</tbody>
</table>

Figure 2 shows the average value of RPN. The highest average value is a budget risk; this means that it is important for financial or budget management to set budget priorities.

Figure 2 - RPN Average

After getting the RPN value for each risk, it will be sorted from the highest to the lowest RPN value so that risk priority will be obtained for the owner of the dam construction work. The sorting results of RPN value as shown in Table 7.
### Table 7 - Risk Ranking Based on RPN Value

<table>
<thead>
<tr>
<th>Failure Mode</th>
<th>Severity</th>
<th>Occurance</th>
<th>Detection</th>
<th>RPN</th>
</tr>
</thead>
<tbody>
<tr>
<td>B.2 Delay in Work progress</td>
<td>4,000</td>
<td>4,000</td>
<td>3,000</td>
<td>48</td>
</tr>
<tr>
<td>B.4 The design investigation study document is not in accordance with the conditions in the field</td>
<td>4,000</td>
<td>4,000</td>
<td>3,000</td>
<td>48</td>
</tr>
<tr>
<td>E.2 Refocusing the Budget</td>
<td>4,000</td>
<td>3,000</td>
<td>3,000</td>
<td>48</td>
</tr>
<tr>
<td>B.3 Rejection of the proposed budget increase plan</td>
<td>3,000</td>
<td>3,000</td>
<td>3,000</td>
<td>48</td>
</tr>
<tr>
<td>B.7 Document Licensing Not in Accordance with the Proposal</td>
<td>3,000</td>
<td>3,000</td>
<td>3,000</td>
<td>48</td>
</tr>
<tr>
<td>C.2 Differences in mechanisms with other ministries</td>
<td>3,000</td>
<td>3,000</td>
<td>3,000</td>
<td>48</td>
</tr>
<tr>
<td>C.1 Communities Resist Land Acquisition</td>
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<td>D.1 Natural Disasters (Landslides, Earthquakes)</td>
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<td>E.1 Proposed Budget Increase Request</td>
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<td>A.1 Negative news on public</td>
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<tr>
<td>A.2 Abandoned work</td>
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<td>B.1 Overpay on a Progress</td>
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<td>B.5 Problematic environmental impact analysis documents</td>
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<td>B.6 Delayed Auction process</td>
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<td>B.8 Structural Failure</td>
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<td>D.2 Design Review</td>
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<td>D.3 The dam cannot operate immediately</td>
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<td>F.1 Execution of Work not in accordance with technical specifications</td>
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<td>F.2 Unsuitable Experts</td>
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<td>G.1 Work accidents resulting in loss of life</td>
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<td>C.3 Delay in Submission &amp; Disbursement of Guarantees to the Bank by the provider</td>
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Figure 3 shows a graph of the risk rating based on the RPN value. The three highest RPN values are in item B.2, delays in work progress, B.4, the design investigation study document is not in accordance with conditions in the field, and E.2, refocusing the budget. These three items must be taken into consideration and the focus of company policy.
In Table 7, it can be seen that the highest risks affecting dam construction work in East Java are Delays in Work Progress, SID Documents not under field conditions, and Budget Refocusing.

4. Conclusions
According to Circular Letter of the Ministry of Public Works and Public Housing Number 04/SE/M/2021, Risk identification is divided into seven (7) criteria; namely reputation risk, performance risk, legal risk, service risk, installment risk, fraud risk, and work accident risk. Each risk has a risk statement which is a sub-type of the risk. Twenty-one (21) risk statements have been identified and have gone through a preliminary questionnaire for dam construction risks in East Java, Indonesia.

A list of risks that have the potential to become high risk in dam construction is obtained. After analysis using the Failure Mode and Effect Analysis method using three criteria, namely severity, occurrence, and detection. The method produces the three highest RPN values are delays in work progress, the design investigation study document is not in accordance with conditions in the field, and refocusing the budget.

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