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Infrastructure Asset Management Study At PDAM Tanah Laut Regency Risk-Based

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ABSTRACT. The performance audit by the Badan Pengawasan Keuangan dan Pembangunan (BPKP) in 2020 resulted in several evaluations that must be carried out immediately by the PDAM Tanah Laut regency, one of which is the absence of asset management policies that have not considered the risk of asset operational failure. The rate of water leakage (non revenue water) was found to be still higher than the standard of 25% at 32.01%. The high nrw is certainly related to the company's critical assets, namely network pipes and physical assets. In addition, mitigation is needed on the management of assets that have the potential to occur risks.

This study aims to identify potential risks, identify potential risks, identify and determine dominant risks and provide risk mitigation recommendations on PDAM infrastructure assets in Tanah Laut Regency. Risk analysis uses probability impact matrix (PIM) risk assessment and Pareto diagram.

This study resulted in a respondent's perception of 59.17% with a total of 32 potential risk variables, consisting of 9 risks in the raw water unit category, 9 risks in the production unit category, 10 risks in the distribution unit category and 4 risks in the service unit category. . Meanwhile, from the analysis that has been carried out, it is obtained that the dominant risk variables that occur in PDAM Tanah Laut assets using both the PIM method and the Pareto diagram are river water receding due to the dry season, leaks in distribution pipes, and power outages from PLN during peak hours. The mitigation strategy is for risks due to receding river water due to the dry season by increasing reservoir capacity and increasing the construction of ponds and reservoirs around the WTP buildings. For risks due to leaks in distribution pipes by providing spare pipes, replacing pipes periodically with better specifications and implementing SOPs related to pipe installation and accessories better. And for risks due to power outages from PLN during peak hours for providing Generator Sets (Gensets), ensure sufficient fuel stocks and coordinate with PLN to find out and obtain blackout schedules. The results of this study are expected to become a reference design for risk-based asset management for PDAM Tanah Laut Regency and handling/controlling risks in asset management to reduce potential losses suffered.

Keywords: PDAM, asset management, risk management, ISO 31000; probability impact matrix, Pareto.

1. INTRODUCTION

Water is a source of basic necessities of life that are needed not only by humans but by all living things in this world (Sanim, 2014). PDAM is a regional-owned enterprise that is included in the category of service providers that are for profit with the task of providing clean water services to citizens in an area (Nugrahani, 2010). In order to optimally fulfill the community's clean water needs, PDAM must of course have good performance. PDAM performance measures are based on indicators set by the Drinking Water Supply System Development Support Agency (BPPSPAM). According to Minister of Public Works Regulation No. 18/2007 article 1(15) "SPAM Development Support Agency, hereinafter referred to as BPP SPAM, is a non-structural body formed by, is under and responsible to the Minister, and is tasked with supporting and providing assistance in order to achieve the goal of developing SPAM in order to provide benefits that are for the country and the greatest prosperity of the people". Performance evaluation consists of four aspects, namely financial aspects, service aspects, operational aspects and human resources aspects.

Risk (Risk) is a hazard, result or consequence that can occur as a result of an ongoing process or event that will come. If the risk befalls the organization, then the organization can suffer significant losses. In some situations, risk can result in the destruction of the organization. Because of this it is important to manage risks (Hanafi in Putra et al, 2018). In order for risk-based asset management to be implemented properly, it is necessary to prepare all risk management infrastructure, including risk management guidelines (policies, general guidelines, procedures and forms), risk management organizational structure (tasks, authorities, responsibilities of personnel to carry out risk management). risk), and information system for reporting/monitoring the implementation of risk management.

The research was conducted in the scope of the Municipal Water Supply System (SPAM) of the District Municipal Installation (IKK) in 9 PDAM areas of Tanah Laut Regency, namely the raw water unit, production unit, distribution unit and service unit. The result of this study is a PDAM asset management plan that calculates risk. This will help PDAM to improve the drinking water infrastructure asset management system so that the company's assets can be properly regulated and managed and contribute to improving the company's performance. Previous research related to this topic has been conducted by Fauzi (2019) with the research title Participatory Risk Management in Drinking Water Production and Distribution Assets (Case Study of Air Kanoman House 1 PDAM Magelang City. Fajar (2018) entitled Analysis of Risk-Based Asset Management Planning in Improving Performance of Regional Drinking Water Companies (PDAM) in Aceh Province. Putra et al (2018), researched ISO 31000-based risk management design in PDAM Tirta Meulaboh. If in similar research, the object of research was carried out only in production and distribution units, then in this study carried out on all SPAM units, namely raw water units, production units, distribution units, and service units so that it is expected to obtain a more comprehensive picture of the potential risks in PDAM asset management.Another difference is that the coverage of PDAM services in Tanah Laut Regency is partly located in coastal areas that are vulnerable to seawater intrusion.

2. RESEARCH METHOD

Data Collection Stage

Primary Data Collection

Primary data is data obtained from the first source at the research location where primary data collection in this study was carried out using several methods, namely:

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1. Questionnaire
   The research instrument used in this study was a questionnaire or a questionnaire made by the researcher himself. This questionnaire will be distributed to respondents in 9 locations of SPAM IKK PDAM Tanah Laut Regency.

2. Observation
   This activity is carried out after the distribution of the questionnaire has been completed, aiming to find out the latest situation regarding the management of operated assets whether they are managed on a risk basis or not. With this observation, a description/condition in the field will be obtained directly which is not influenced by other concepts/views, the researcher can see things that are lacking or not observed by others.

3. Interview
   Interview activities were carried out after the data from the questionnaires had been processed and resulted in the required analysis. The interview aims to obtain more in-depth data, to know clearly about opinions, input or recommendations for risk-based mitigation strategies in planning PDAM Tanah Laut Regency assets. Therefore, the interviews in this study were addressed to policy stakeholders (relevant agencies, the directors of PDAM Tanah Laut Regency).

Secondary Data Collection

Secondary data is data obtained indirectly by the documentation method to support research in the form of:

1. SPAM Asset Management Technical Manual, RPAM, PDAM Profile of Tanah Laut Regency, PDAM Asset Data of Tanah Laut Regency.
2. Other sources such as journal literature, and research reports related to risk-based asset management.

Data processing

To get the purpose of this study, there are several analyzes used, namely for objective 1 with descriptive analysis, objective 2 with PIM and FMEA analysis and objective 3 with observation and interviews. In detail, the data processing is carried out as follows:

1. Descriptive Analysis
   The descriptive analysis method is a method used to analyze data by describing and classifying the collected data so as to provide a clear picture of the respondent's profile or information regarding the risk-based management of PDAM Tanah Laut Regency infrastructure assets. Observations from secondary data are presented with descriptive statistics.

2. Questionnaire Validity and Reliability Check
   This test was conducted to measure the level of validity and reliability of the questions in the questionnaire. This research was conducted on 30 respondents located in 9 locations of SPAM IKK PDAM Tanah Laut Regency with 32 questions. The results of filling out the questionnaire were then processed using the Spearman's Rank test. If the results of $-Z_{table} < Z_{count} < +Z_{table}$, it can be concluded that all the variables used have no significant relationship, which means that each of each variable does not affect the other variables. so it can be concluded that all items are valid.

While the reliability test was carried out by computerization using the Cronbach technique. Alpha. If the measurement results of the 32 question items are > 0.60, then it can be said that all the question items in the questionnaire are reliable.

3. Data Analysis
   After ensuring that the data is declared reliable and valid, the next step is to carry out a risk analysis on PDAM infrastructure assets in Tanah Laut Regency using the PIM method and Pareto Diagrams. PIM is used to determine risk priority areas by considering the severity (severity due to failure) and Occurance (frequency of possible failures) while the Pareto diagram is used to provide the highest ranking to the lowest in the form of images. Later these two methods will be compared to obtain urgent mitigation recommendations to be implemented in the short term.
   a. Risk Identification
      Risk identification is carried out by distributing preliminary questionnaires using 'yes' or 'no' answers. If the respondent answers 'yes' to one of the risk options, then that risk will be included in the next stage of the questionnaire form.
   b. Analysis with the PIM Method
      The steps for calculating the analysis of the PIM method are as follows:
      1) Measurement of potential risk with the Severity Index
      2) Assessment of Probability and Risk Impact
      3) Risk evaluation
   c. FMEA analysis
      1) Calculation of RPN (Risk Priority Number)
      2) Asset Failure Risk

3. RESULTS AND DISCUSSION

Respondent Identity

Respondents in this study totaled 30 people, who are PDAM Tanah Laut Regency employees who have positions as unit heads and operators who work in 9 SPAM IKK locations spread across Tanah Laut Regency. In filling out the questionnaire, respondents were accompanied by researchers to guide and explain the purpose of the questionnaire questions. The respondent's data can be classified into several characteristics based on position, work experience in PDAM, gender, age and recent education.

Validity and Reliability

- Probability Impact Questionnaire Test

  Questionnaire Validity Test

  To test the PIM questions, a validity test was used using the Spearman's Rank correlation test. The test was carried out with a 2-way test which means that the test was carried out to see the level of influence of each risk event variable in the questionnaire. The level of influence generated in this correlation test has results with a 95% confidence level alpha 0.05

Table 3.1 Recapitulation of Calculation Results Between Each Item and Total

Variable	Rs	Z_{count}	alpha	Z_{table} lower	Z_{table} upper	Results	e.g
item 1	0,628	0,117	0,05	-1,960	1,960	Ho accepted	Valid
item 2	0,797	0,148	0,05	-1,960	1,960	Ho accepted	Valid
item 3	0,655	0,122	0,05	-1,960	1,960	Ho accepted	Valid
item 4	0,797	0,148	0,05	-1,960	1,960	Ho accepted	Valid
item 5	0,797	0,148	0,05	-1,960	1,960	Ho accepted	Valid
item 6	0,797	0,148	0,05	-1,960	1,960	Ho accepted	Valid
item 7	0,847	0,157	0,05	-1,960	1,960	Ho accepted	Valid
item 8	0,552	0,102	0,05	-1,960	1,960	Ho accepted	Valid
item 9	0,708	0,131	0,05	-1,960	1,960	Ho accepted	Valid
item 10	0,818	0,152	0,05	-1,960	1,960	Ho accepted	Valid
item 11	0,797	0,148	0,05	-1,960	1,960	Ho accepted	Valid
item 12	0,797	0,148	0,05	-1,960	1,960	Ho accepted	Valid
item 13	0,797	0,148	0,05	-1,960	1,960	Ho accepted	Valid
item 14	0,627	0,116	0,05	-1,960	1,960	Ho accepted	Valid
item 15	0,621	0,115	0,05	-1,960	1,960	Ho accepted	Valid
item 16	0,700	0,130	0,05	-1,960	1,960	Ho accepted	Valid
item 17	0,797	0,148	0,05	-1,960	1,960	Ho accepted	Valid
item 18	0,675	0,125	0,05	-1,960	1,960	Ho accepted	Valid
item 19	0,797	0,148	0,05	-1,960	1,960	Ho accepted	Valid
item 20	0,687	0,128	0,05	-1,960	1,960	Ho accepted	Valid
item 21	0,621	0,115	0,05	-1,960	1,960	Ho accepted	Valid
item 22	0,797	0,148	0,05	-1,960	1,960	Ho accepted	Valid
item 23	0,745	0,138	0,05	-1,960	1,960	Ho accepted	Valid
item 24	0,797	0,148	0,05	-1,960	1,960	Ho accepted	Valid
item 25	0,705	0,131	0,05	-1,960	1,960	Ho accepted	Valid
item 26	0,645	0,120	0,05	-1,960	1,960	Ho accepted	Valid
item 27	0,697	0,129	0,05	-1,960	1,960	Ho accepted	Valid
item 28	0,621	0,115	0,05	-1,960	1,960	Ho accepted	Valid
item 29	0,797	0,148	0,05	-1,960	1,960	Ho accepted	Valid
item 30	0,797	0,148	0,05	-1,960	1,960	Ho accepted	Valid
item 31	0,684	0,127	0,05	-1,960	1,960	Ho accepted	Valid
item 32	0,797	0,148	0,05	-1,960	1,960	Ho accepted	Valid

Based on Table 3.1 it shows that Zcount is more than -Ztable and less than +Ztable, so it can be concluded that all the variables used have no significant relationship, which means that each of each variable does not affect the other variables. so that it can be concluded that all PIM questions are valid.

Questionnaire Reliability Test

Reliability analysis is used to test whether the questionnaire is reliable or not. If reliable, it means that the questionnaire can be used for repeated measurements with the same subject and give relatively the same or no different results. To measure reliability, in this study the Cronbach's

Alpha test was used using the SPSS program. If the Cronbach's Alpha calculation results are > greater than 0.6, then these aspects are reliable

Table 3. 2 Results of the Probability Impact Questionnaire Reliability Test Output

Cronbach's Alpha	N of Items
0,958	32

- FMEA Questionnaire Test

Questionnaire Validity Test

For the FMEA question questionnaire (Failure Modes and Effects Analysis) validity test was used using the Spearman's Rank correlation test. As well as testing the validity of the PIM question questionnaire above, the level of influence produced in this correlation test has results with a 95% confidence level alpha 0.05.

Table 3.3 Recapitulation of Calculation Results Between Each Item and Total

Variable	**Rs**	**Z_{count}**	**alpha**	**Z_{tabel}**		**Results**	**e.g**
				lower	**upper**		
item 1	0,717	0,133	0,05	-1,960	1,960	Ho accepted	Valid
item 2	0,768	0,143	0,05	-1,960	1,960	Ho accepted	Valid
item 3	0,752	0,140	0,05	-1,960	1,960	Ho accepted	Valid
item 4	0,628	0,117	0,05	-1,960	1,960	Ho accepted	Valid
item 5	0,753	0,140	0,05	-1,960	1,960	Ho accepted	Valid
item 6	0,753	0,140	0,05	-1,960	1,960	Ho accepted	Valid
item 7	0,675	0,125	0,05	-1,960	1,960	Ho accepted	Valid
item 8	0,387	0,072	0,05	-1,960	1,960	Ho accepted	Valid
item 9	0,655	0,122	0,05	-1,960	1,960	Ho accepted	Valid
item 10	0,731	0,136	0,05	-1,960	1,960	Ho accepted	Valid
item 11	0,755	0,140	0,05	-1,960	1,960	Ho accepted	Valid
item 12	0,482	0,089	0,05	-1,960	1,960	Ho accepted	Valid
item 13	0,769	0,143	0,05	-1,960	1,960	Ho accepted	Valid
item 14	0,557	0,103	0,05	-1,960	1,960	Ho accepted	Valid
item 15	0,665	0,124	0,05	-1,960	1,960	Ho accepted	Valid
item 16	0,515	0,096	0,05	-1,960	1,960	Ho accepted	Valid
item 17	0,736	0,137	0,05	-1,960	1,960	Ho accepted	Valid
item 18	0,734	0,136	0,05	-1,960	1,960	Ho accepted	Valid
item 19	0,754	0,140	0,05	-1,960	1,960	Ho accepted	Valid
item 20	0,602	0,112	0,05	-1,960	1,960	Ho accepted	Valid
item 21	0,706	0,131	0,05	-1,960	1,960	Ho accepted	Valid
item 22	0,736	0,137	0,05	-1,960	1,960	Ho accepted	Valid
item 23	0,631	0,117	0,05	-1,960	1,960	Ho accepted	Valid
item 24	0,736	0,137	0,05	-1,960	1,960	Ho accepted	Valid

item 25	0,667	0,124	0,05	-1,960	1,960	Ho accepted	Valid
item 26	0,687	0,128	0,05	-1,960	1,960	Ho accepted	Valid
item 27	0,688	0,128	0,05	-1,960	1,960	Ho accepted	Valid
item 28	0,506	0,094	0,05	-1,960	1,960	Ho accepted	Valid
item 29	0,766	0,142	0,05	-1,960	1,960	Ho accepted	Valid
item 30	0,755	0,140	0,05	-1,960	1,960	Ho accepted	Valid
item 31	0,762	0,141	0,05	-1,960	1,960	Ho accepted	Valid
item 32	0,777	0,144	0,05	-1,960	1,960	Ho accepted	Valid

Based on Table 3.3 it shows that Zcount is more than -Ztable and less than +Ztable, so it can be concluded that all the variables used have no significant relationship, which means that each of each variable does not affect the other variables, so it can be concluded that all FMEA questions are valid.

Questionnaire Reliability Test

FMEA question reliability analysis was carried out with the help of SPSS. The results of testing the reliability of the questionnaire are shown in Table 3.4

Table 3. 4 Output Results of the Reliability Test on the FMEA Questionnaire

Cronbach's Alpha	N of Items
0,944	32

From the value above, the reliability coefficient value for 32 questions was 0.944, where the value was > 0.60, it was concluded that all questionnaire instruments were declared reliable or a good coefficient level. Because the results are known that all research variables are valid and all instruments are reliable. Then 32 questions can be declared reliable/feasible for further analysis.

Respondents' Perceptions of PDAM Asset Risk Potential

The results of the research questionnaire on respondents' perceptions of the question whether the assets in each SPAM IKK unit that have been managed so far have potential risks can be seen in Table 3.5

Table 3.5 Respondents' Answers Regarding Potential Risks in PDAM Assets

No.	**Question Items**	**Risk Variable**	**Answers from 30 respondents to 32 question items whether the assets being managed have potential risks**	
			Yes	**No**
1	There was seawater intrusion into the river	R1	3	27
2	Water is polluted due to mining activities (eg coal and gold) and land clearing activities in the upstream area of the river	R2	14	16
3	The low tide of the river in the dry season	R3	27	3

4	Increased acidity (aggressiveness) of river water due to clearing of peat areas in the upstream area	R4	3	27
5	The groundwater table is getting lower due to over-utilization and reduced catchment area.	R5	3	27
6	Pollution of groundwater due to domestic waste, mining (heavy metals) and agriculture (pesticide).	R6	3	27
7	The intake building was damaged by the flood	R7	9	21
8	The intake pump motor often burns out due to low tide and dirt blockage	R8	27	3
9	Interference with the transmission pump motor	R9	25	5
10	The installation spiral pipe/pipe is old/porous	R10	3	27
11	The storage and security of chlorine gas cylinders is not safe and there is no separation of cylinders from pumping equipment and panels	R11	3	27
12	Unavailability of minimum coagulant stock	R12	3	27
13	Incorrect in determining the dose of coagulant (lack of dose)	R13	26	4
14	Incorrect dosing pump stroke setting	R14	25	5
15	Chemical leaks in pipes and valves	R15	26	4
16	The rapid mixer is broken	R16	27	3
17	The turbidity of the raw water to be treated is very low so that the floc breaks and enters the filtration unit	R17	5	25
18	The turbidity of raw water is very high (200-1000 NTU) so that the processing is not optimal so it requires additional chemicals (PAC powder)	R18	7	23
19	During the maintenance process, the manhole cover was not installed properly	R19	3	27
20	There was an overflow/overflow of clean water in the reservoir	R20	27	3
21	The amount of sediment that settles at the bottom of the reservoir tank	R21	26	4
22	Transformer power is not as needed	R22	3	27
23	Power outages from PLN during peak hours	R23	27	3
24	Unscheduled Transformer Operation and Maintenance (ex: oil change)	R24	27	3
25	Fault in distribution pump motor	R25	27	3
26	Leaks in distribution pipes	R26	27	3
27	The technical quality of the pipe installation is not good	R27	27	3
28	The technical quality of the installation of distribution pipe accessories is not good	R28	27	3

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29	Leaks in boring	R29	27	3
30	Water meter installation leaks	R30	27	3
31	Poor technical quality of water meter installation (not according to SOP)	R31	27	3
32	Regular meter/tera replacement is not scheduled	R32	27	3
	Average		17,75	12,25
	Percentage		59,17%	40,83%

The table above shows that 59.17% of respondents answered that there is a potential risk to the PDAM assets of Tanah Laut Regency which they have been operating so far.

Asset Risk Analysis with the PIM Method

Based on the classification of each risk factor, it is then plotted against the dominant asset risk variable in the matrix as shown in Figure 3.1

Opportunity		1- Very small	2 - Small	3 - Currently	4 - Big	5 - Very large
5	Very high					
4	High					R3, R23, R26
3	Enough			R7	R8, R9, R14, R15, R20, R21, R25, R27, R28	
2	Low			R1, R2, R4, R5, R6, R10, R11, R12, R13, R17, R18, R19, R22, R24, R29, R30, R31, R32	R16	
1	Very low					
		Impact				

Figure 3.1 PDAM Asset Risk Matrix Map of Tanah Laut Regency

Asset Risk Analysis Using the FMEA Method

After calculating the RPN value by multiplying the values of Severity, Occurance and Detection, the priority scale is determined using the Pareto diagram by sorting the risks based on the highest RPN value and calculating the weight for each item.

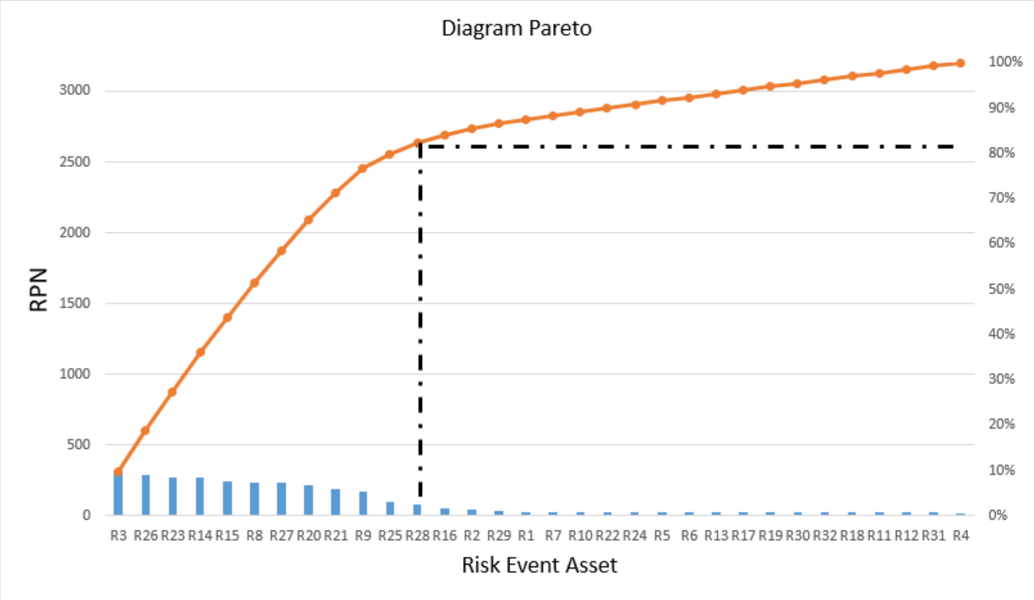

Figure 3.2 Pareto Diagram of PDAM Asset Risk in Tanah Laut Regency

Dominant Asset Risk with Each Method

- Dominant Risk with the PIM Method

From the calculation of the risk level using the PIM method, it can be determined that the dominant risk of PDAM Tanah Laut Regency's assets is 12 variables that fall into the very high and high categories. The 12 dominant risks are shown in Table 3.6

Table 3.6 Dominant risks (PIM Method)

No.	Variable	*Risk Event*	Category
1	R3	The river water receded due to the dry season	Very high
2	R23	Power outages from PLN during peak hours	Very high
3	R26	Leaks in distribution pipes	Very high
4	R8	The intake pump motor often burns out due to low tide and dirt blockage	High
5	R9	Interference with the transmission pump motor	High
6	R14	Incorrect stroke setting on the dosing pump	High
7	R15	Chemical leaks in pipes and valves	High
8	R20	There was an overflow/overflow of clean water in the reservoir	High
9	R21	The amount of sediment that settles at the bottom of the reservoir tank	High
10	R25	Fault in distribution pump motor	High
11	R27	The technical quality of the pipe installation is not good	High
12	R28	The technical quality of the installation of distribution pipe accessories is not good	High

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- Dominant Risk with the FMEA Method

As for the dominant risk of PDAM assets in Tanah Laut Regency, 12 variables with the highest RPN value were obtained using the FMEA method. The 12 dominant risks are as shown in Table 3.7

Table 3.7 Dominant risk (Pareto Chart)

No.	Variable	*Risk Event*	RPN Value
1	R3	The river water receded due to the dry season	306,48
2	R26	Leaks in distribution pipes	292,77
3	R23	Power outages from PLN during peak hours	273,37
4	R14	Incorrect stroke setting on the dosing pump	273,19
5	R15	Chemical leaks in pipes and valves	247,38
6	R8	The intake pump motor often burns out due to low tide and dirt blockage	238,55
7	R27	The technical quality of the pipe installation is not good	231,46
8	R20	There was an overflow/overflow of clean water in the reservoir	214,70
9	R21	The amount of sediment that settles at the bottom of the reservoir tank	187,04
10	R9	Interference with the transmission pump motor	174,57
11	R25	Fault in distribution pump motor	97,08
12	R28	The technical quality of the installation of distribution pipe accessories is not good	83,22

4. CONCLUSIONS

Respondents' perceptions of the potential risk of managing PDAM Kab assets. Tanah Laut is 59.17% with a total of 32 potential risk variables, consisting of 9 risks in the raw water unit category, 9 risks in the production unit category, 10 risks in the distribution unit category and 4 risks in the service unit category.

The results of the PIM analysis are obtained from the priority risk areas depicted in the matrix map based on very high, high, medium and low categories, while the results of the risk analysis using the FMEA method are obtained from the results of the RPN rating. The analysis results obtained from the FMEA method are more systematic and practical because the risk variables analyzed have been arranged sequentially and ranked.

The risk caused by receding river water due to the dry season can lead to reduced availability of raw water for production. Mitigation that can be done is to increase reservoir capacity and increase the construction of reservoirs and reservoirs around the IPA building.

The risk due to leaks in distribution pipes that can cause disruption of water distribution in service areas, environmental disturbances (damaged roads), complaints from customers, increased water loss, and the company's image will decrease. Mitigation of this can be done by providing spare pipes, replacing pipes periodically with better specifications and implementing SOPs related to pipe installation and accessories better.

The risk caused by blackouts from PLN during peak hours will result in increased fuel use, increased production costs, and can even stop production. To overcome this, mitigation can be done to replace Generator Sets (Gensets), ensure sufficient fuel stocks and coordinate with PLN to find out and obtain blackout schedules.

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