Risks Analysis for Production and Distribution System in Local Water Supply Utility

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Abstract

Food and beverages risks in production and distribution system are the critical issues for practitioners and researchers. Accidents in food and beverages risks can cause human health to be impaired. The objectives of this research are to analyze the risks events and recommend the improvement action in the local water supply utility. The house of risks method is used to analyze the risks and determine the improvement actions in case study. In the first stage of house of risks method, identification and determine occurrence, severity, and detection and calculate the aggregate risk potential of agent (ARP). In the second stage, determining preventive action to understand the highest risks events. Based on brainstorming with the managers and using the Fishbone Diagram, the improvement action could be determined. The implication practices will be described based on the results of this study in conclusion sections.

Keywords

Water Supply, Risk Management, House of Risk

1. Introduction

The water supply utility was formed with the objectives to provide healthy, affordable, and safe drinking water for the community (Pollard et al 2004). In Indonesia, the water supply utility is carried out by local water companies as one of the local-owned business units. The local water supply utilities produce and distribute clean water to their consumers. The local water supply utility is available in every province, district, and municipality throughout Indonesia. In the Dutch era around the 1920s, the local water supply companies had been managed by locally owned business units because clean water was the primary need of the community and affected the health of the community.

Many companies in almost all industrial sectors use risk management to manage risks that have occurred or have not yet happened, including the industrial water supply utility. Risk identification, analysis, and management techniques have been widely applied in several industrial sectors. Some researchers have previously carried out risk management studies in water supply utilities. Development and implementation of a water safety plan for water quality management using the HACCP approach (Dewettinck et al 2001; Hellier 2000). How is the relationship between water utilities and financial risk in water supply utilities (Strutt 2003). However, there are still not many who do risk analysis on the production system and its distribution. The risk of water leaks and others is often found and reported in the news media. Several previous studies in the operation level of the water utility sectors have been conducted to risk analysis. Author (Parr and Cullen 1988) assessed the reservoir safety in operation and structural condition using fault and event tree analysis. (Wirth and Siebert 2000) assessed health and safety hazards for chemicals in water and waste in water treatment works using risk ranking, HAZOP (Hazard

and Operability), FMEA (Failure Mode AND Effect Analysis), and FTA (Fault Tree Analysis). Author (Leverrett 2003) conducted a risk analysis using process risk assessment and project contingency planning using risk ranking.

The local water supply utility in the case study has a vision and mission to achieve all the targets that have been determined. According to data from the current local water supply utility in 2019 (Agus 2018), it has the capacity to produce ready to use water of 11,648 liters / second to meet the water needs of the surrounding community. There are several problems experienced by the local water supply utility that is based on the data obtained that there is a level of loss every year is increasing from the coverage area (Alan 2017). Production and distribution are significant process business in water utility industry, but few previous studies conducted risk analysis to manage risks events. The significant risk events were also occurring in production and distribution such as damaged water meters, failure of the production process, and others. The purpose of this study is to develop risk analysis for production and distribution in water utility industry. A case study in local water utility company in Surabaya was conducted to applied the proposed risk analysis. We use House of Risk (HOR) model (Nyoman and Geraldin 2009) to analyze the risk events for production and distribution processes in the water utility company. In this study, HOR is used because it can identify risk events and risk agents in the production process in terms of the supply chain process.

2. Research Method

The stages of research design in this study used stages in some related research (Nyoman and Geraldin 2009; Dewa et al 2017; Vanany et al 2019; Wahyuni et al 2018). The application of house of risk method in water supply utility is to determine the risks that occur and values the severity. Water supply utility has two water treatment facilities for the production and distribution of water supply to the community. The raw material used by water from a flowing river is also processed and distributed using pipes to the people of the region. As a company of government, the price of marketing and distribution of products must comply with government regulations. In this research, the data collection method used is by taking primary data from the daily operational report of production and distribution department to know all the risks as well as interviewing the supervisor to determine the score of severity and occurrence. Figure 1 showed the flow of data collection.

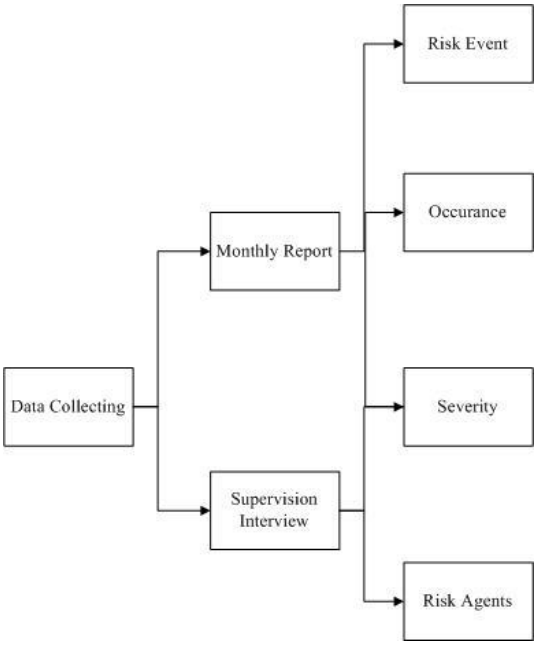

Figure 1. Research data collecting chart

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3. Case Study

This study was conducted to identify risk events (risk events) and risk agents (causes of risk) in the production process of water supply utility and mitigation strategies using the House of Risk (HOR) method. The local water supply utility is a company that supplies clean water needs for the surrounding community. This company has a

vision and mission to achieve all the targets that have been determined. According to data from the current local water supply utility in 2019 (Agus 2018), it has the capacity to produce ready to use water of 11,648 liters / second to meet the water needs of the surrounding community. There are several problems experienced by the local water supply utility that is based on the data obtained, that there is a level of loss every year is increasing from the coverage area.

Table 1. Mapping Activities.

Major Processes	Sub-Processes	Risk Event (Severity)	Code
Source	Make sure raw materials occupy the standard Processing water supply	Water pollution in raw water	ES1
		Climate factors	ES2
Make	Processing water supply Distribution water supply	Power outages in the production process	EM1
		Work accident in production work area	EM2
		The quality of affixing chemicals	EM3
		Error analysis jartes	EM4
		Damage the production process pump	EM5
		Failure of the pre-sedimentation process	EM6
		Damage the electrical panel in the production process	EM7
		Failure of the aeration process	EM8
		Valve damage in the production process	EM9
		Damage the compressor in the production process	EM10
		Failure of the coagulation and flocculation processes	EM11
		Failure of the sedimentation process	EM12
		Failure of the filtration process	EM13
		Pipe damage in the production process	EM14
		Failure of disinfection process	EM15
		Blower damage	EM16
		Failure reservoir to storage water	EM17
Delivery	Distribution water supply Service Complaints	Damage the valve in the distribution system	ED1
		There are leaks in several distribution areas	ED2
		Changes in the size of distribution pipes in certain areas	ED3
		Blockage in distribution pipe	ED4
		Distribution pipeline planning is not right	ED5

3.1 Risk Identification

The phase of risk identification is a step to carry out the identification of risks that may arise during the production process and distribution of water supply. The results of this phase are in the form of a list of existing risks both in the form of risk events and sources of potential risk agents. A risk agent can cause several risk events. By using the Supply Chain Operation Reference (SCOR) model. The Authors (Nyoman and Geraldin 2009) SCOR is structured into five different management processes: Plan, Source, Make, Deliver and Return, so in the process of production and distribution of water supply various risk events can be obtained. Table 1 shows the mapping of activities for water supply utility.

4. Results and Discussions

In this study, after the identification step, is to conduct an assessment of the severity level. The severity of a risk event and occurrence assessment, is the level of opportunity for a risk event to occur. This can be done by using the House of Risk phase 1 method using a correlation matrix between risk events and risk agents which are weighted respectively. In water supply processing utility in the production process and distribution, there are 24 risk events and 20 risk agents. Each risk event and risk agent have each correlation value.

4.1 House of Risk Phase 1

House of Risk method, where HOR phase 1 is a risk identification phase that is used to determine the risk agent that must be given priority for preventive action. The steps in this phase 1 HOR are risk identification and risk assessment which include assessing the level of impact (severity), assessing the level of emergence (occurrence), assessing the correlation (correlation) and calculating the value of the Aggregate Risk Potential (ARP), so that it can be known which risk agents will be given a precautionary measure by ordering ARP values. After calculating the HOR phase 1, the highest ARP value occurs when routine maintenance is not carried out in the production process and distribution of water utilities. The highest value of the risk agents reached 1071 and the lowest value was 30 from the ARP calculation process. Table 2 shows the formula and calculation of House of Risk Phase 1.

Table 2. Table for calculating ARP on house of risk phase 1.

Risk Events	Risk Agent					Si
	A1	A2	A3	A4	A5	
E1	R11	R12	R13	...	...	S1
E2	R21	R22	...	...	...	S2
E3	R31	...	...	...	...	S3
E4	...	...	...	...	...	S4
E5	...	...	...	...	...	S5
Oj	O1	O2	O3	O4	O5	O6
ARPj	ARP1	ARP2	ARP3	ARP4	ARP5	ARP6
Pj	P1	P2	P3	P4	P5	P6

$$ARPj = Oj \sum Si\ Rij \tag{1}$$

Based on the calculation of the Aggregate Risk Potential (ARP) in HOR phase 1, a Pareto diagram was made to determine the risk agent that influences the risk in the production and distribution process. The risk agents are shown in Table 3. In accordance with the principle of the 80-20 Pareto diagram, the priority problem that must be resolved is a problem with a percentage of up to 80% and can be seen in Figure 2.

Table 3. Risk agents.

No	Code	Risk Agents	ARP	Ranking
1	AM9	No routine maintenance	1071	1
2	AM4	Operator is not competence	996	2
3	AM12	No Routine checking for daily	864	3
4	AM11	No spare part there	498	4
5	AM1	Tools damage	426	5
6	AS2	Weather changes	423	6
7	AD2	Regional Development	396	7
8	AS1	Industrial and domestic waste	348	8
9	AD4	No knowledge about GIS	297	9
10	AM10	Tools factor ages	243	10
11	AM8	The quality and quantity of chemicals do not match	216	11
12	AM5	No Standard Operational Procedure	210	12
13	AM2	Electric power is overload	180	13
14	AM3	No spare part tools	153	14
15	AM6	No ergonomic for building structure	135	15
16	AD1	Overpressure from other pipes	135	15
17	AD3	There is sludge in pipe distribution	135	15
18	AM13	The quality of the filter media is not good	81	18
19	AM14	Reservoir building is broken or have a crack	36	19
20	AM7	No safety sign for dangerous area	30	20

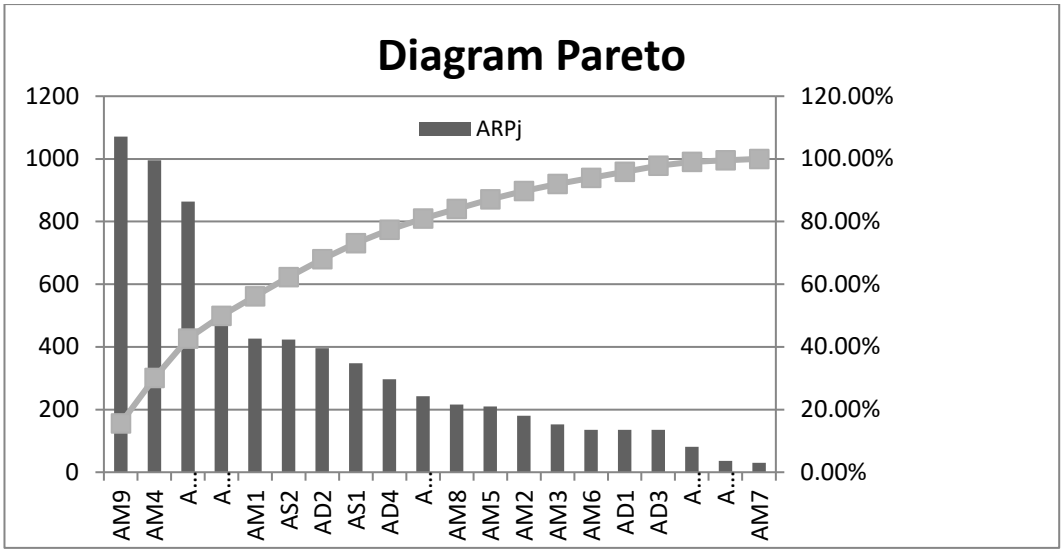

Figure 2. Pareto diagram.

After illustrated by the Pareto diagram, there are 10 risk agents whose ARP values exceed 80%. Then the risk agents will be given preventive actions. Preventive action is provided by including risk agents in HOR phase 2. In this HOR phase 2, several preventive actions will be chosen which are considered effective to reduce the impact caused by risk agents. The steps in HOR phase 2 start with the preventive action plan, looking for the relationship between the preventive action and the existing risk agent, calculating the value of Total Effectiveness (TEk) and degree of difficulty (Dk) and finally calculating the ratio of Effectiveness to difficulty (ETDk) to determine the ranking priority of existing preventive action.

4.2 House of Risk Phase 2

Based on the 10 risk agents shown by the Pareto diagram, there are several treatment preventive actions recommended that can allow to eliminate or reduce the emergence of these risk agents. In the table, some preventive actions that can be recommended to water supply companies based on the selected risk agents are 13 preventive actions that can be used to eliminate or reduce the emergence of risk agents. The preventive actions to eliminate or reduce the risk agents are shown in Table 4.

Table 4. Preventive action.

No	Preventive Action	Code
1	Scheduling maintenance on periodically	PA1
2	Provides equipment that suits needs	PA2
3	Conduct or hold regular training to improve operator competency	PA3
4	Conduct evaluation performance of operators	PA4
5	Establish an inspection team	PA5
6	Schedule inspections	PA6
7	Plan and calculate spare parts requirements	PA7
8	Make a report of damage the tool and monitor the report	PA8
9	Expanding the development of geomembrane technology	PA9
10	Monitor the development of the region and coordinate with the region	PA10
11	Adding a dose of chemical content to reduce the content of pollutants in water	PA11
12	Coordination with GIS	PA12
13	Scheduling replacement of tools that are too old or damaged	PA13

In Table 5 HOR phase 2, the company can find out which preventive actions are considered effective in reducing the probability of risk agents. In the Table 5 HOR phase 2 shows that the company will choose a strategy that is considered effective to reduce the probability of the cause of risk. The choice of preventive action by the company can be seen based on ranking by looking at the existing RTD values.

Table 5. House of risk phase 2.

	Preventive Action													
Risk Agents	PA1	PA2	PA3	PA4	PA5	PA6	PA7	PA8	PA9	PA10	PA11	PA12	PA13	ARP
AM9	9	9				3		9						1071
AM4			9	9										996
AM12	3	3	3		9	9		3						864
AM11		9					9	9						498
AM1	9	3					3	9						426
AS2									9					423
AD2										9		9		396
AS1			9								9			348
AD4			9									9		297
AM10	3	9											9	243
Total Effectiveness (TEk)	16794	20178	37449	8964	7776	10989	5760	20547	3807	3564	3132	6237	2187	
Degree of Difficulty	4	4	5	3	4	4	2	4	3	4	3	4	4	
Effectiveness To Difficulty (ETD)	4198,5	5044,5	7489,8	2988	1944	2747,25	2880	5136,75	1269	891	1044	1559,25	546,75	

After calculating in HOR phase 2, there are several preventive actions that can be prioritized to improve by management. There are 7 preventive actions that must be prioritized. The top of preventive action is that management must have regular training to improve the competency of the operator. The percentage can be shown on Figure 3.

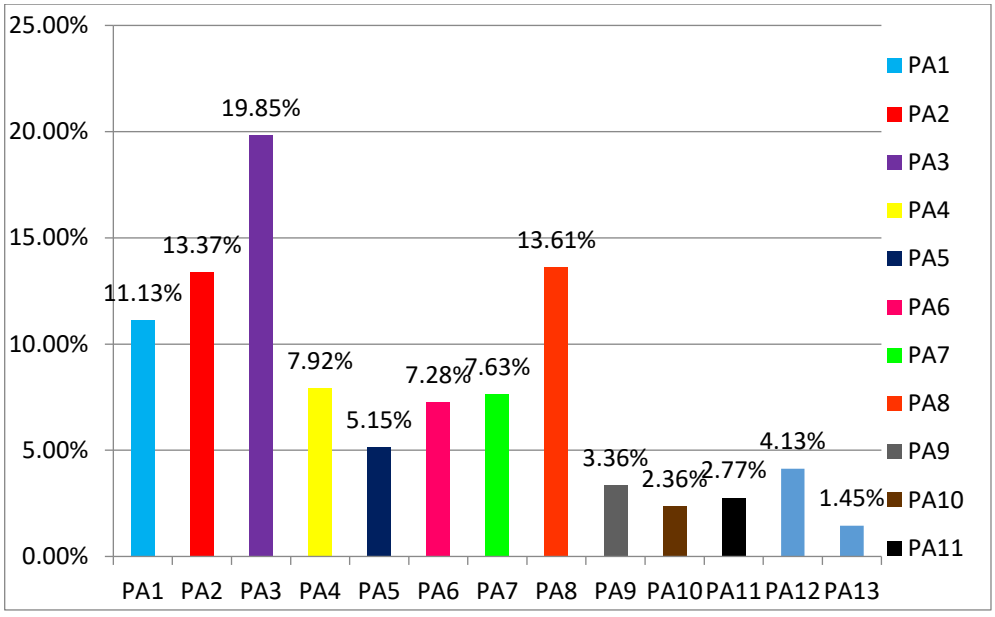

Figure 3. Percentages of preventive actions.

5. Conclusions

Based on the House of Risk Method, there are 24 risk events and 20 risk agents for water supply utility in the production process and distribution. Each risk event and risk agent have each correlation value. The highest value for ARP in HOR step 1 is 1071, the AM9 risk agent code. Then, it is also shown in Pareto diagram that there are 10 risk agents whose ARP values exceed 80%. The risk agent will be given a handling strategy. In the stage 2 HOR, several handling strategies will be chosen which are considered effective to reduce the impact caused by risk agents. There are 13 strategies that can be used to eliminate or reduce the emergence of risk agents. The priority for preventive action is to do the training routine for employees with ETD value of 7490. These recommendations can be made to reduce the risk of water supply to reduce unreliable for water supply.

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