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Work Accident Risk Analysis in the Laboratory of PT. X with FMEA Method

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Abstract:- PT. X is a testing laboratory that has been accredited by KAN (National Accreditation Committee), which is engaged in environmental testing services. This dangerous work environment will certainly result in a large amount of work accident risk. This problem needs to be overcome to reduce workplace accidents that might occur. This research focuses on the FMEA (Failure Mode Effects Analysis) method to identify work accidents that occur and then determine the level of risk. Finally, work accidents that have occurred are determined by the risk level calculated by the value of the RPN (Risk Priority Number). This study found ten work accidents that have the potential to occur in building projects that are used as research objects. The ten work accidents are calculated each RPN value to determine the level of risk. Based on the value of the RPN, the study found that the analysis preparation work on the lab table had the highest RPN value so it can be concluded that this work needs attention to improve its safety against work accidents.

Keywords:- *Work Accident, FMEA (Failure Mode And Effects Analysis), Severity, Occurance, Detection, (RPN) Risk Priority Number.*

I. INTRODUCTION

A. Background

Occupational safety and health (K3) is a thought and effort to ensure wholeness and perfection both physically and spiritually. Work safety has been a concern among governments and businesses for a long time. The safety factor becomes very important because it is related to employee performance and to company performance.

One type of hazardous work is in the Laboratory. The laboratory is a place for conducting experiments, research and development, or quality control. Working in the Laboratory will not be separated from the various kinds of possible dangers of the materials used. In addition, the equipment in the Laboratory can also cause a high risk hazard for people who are conducting research if they do not know how and how to use the equipment to be used.

Understanding and awareness is needed for safety and work hazards in the Laboratory. There have been many accidents or injuries that are permanent, minor injuries, or internal health problems that can cause chronic or acute illness, as well as damage to laboratory supporting facilities and equipment such as instruments which are very expensive. All work events or accidents at the Laboratory can actually be avoided and anticipated if workers at the Laboratory know and always follow safe work procedures at the workplace.

Laboratory Safety is an important matter, as a safety measure in working in the Laboratory, with the aim of protecting workers and those around them from the risk of health problems caused in the Laboratory. Working safely and safely means reducing the risk of accidents.

PT. X is a testing laboratory that has been accredited by KAN (National Accreditation Committee), which is engaged in environmental testing services. Work accidents as analysts often occur in material testing. This problem needs to be addressed to reduce workplace accidents that might occur. The following is work accident data at PT. X in 2013-2018.

No	Type of Work Accident	Number of Incidents
1	Eye accident	8
2	Inhalation of hazardous gas	12
3	Irritations	27
4	Hit by glass	38
5	Injury lifts heavy items	10
6	Burns	9
7	Bad odor	7
8	Chemical spills	49
9	Fatigue	2
10	Slip	3

Table 1:- Table Frequency of Occupational Accidents in the Laboratory of PT. X of 2013 - 2018
Source : PT.X

Based on the description above, the authors will conduct a study to reduce the risk of workplace accidents with the research title: "Work Accident Risk Analysis in the Laboratory of PT. X With the Failure Mode And Effects Analysis (FMEA) Method".

B. Formulation of the Problem

Based on the background described above, the problem formulation in this study is as follows:

1. What are the potential hazards of work accidents in the activities of analysts at PT. X ?
2. What is the level of risk of workplace accidents in the activities of analysts at PT. X ?

C. Research Purposes

The objectives in this study are:

1. Knowing the potential work hazards in testing activities in the Laboratory of PT. X.
2. Knowing the level of risk of work accidents in the activities of analysts at PT. X.

D. Scope of Problem

The limitations used in this study are as follows:

1. Research conducted on the risk of work accident analysts in the laboratory of PT. X in testing environmental test materials.
2. Environmental factors that influence are in a fixed condition, including human factors that work.
3. The data used are 2013-2018.
4. The method used is the FMEA method.

II. LITERATURE REVIEW

A. Definition of Occupational Health and Safety

Chris Rowley & Keith Jackson (2012), said that: "Health and safety or more precisely, occupational health and safety (K3) - pay attention to risk management issues at work where the risk can end in an accident, injury , or poor health."

B. *FMEA Method in Work Safety Management*

According to Pande as quoted by Emi Rusmiati (2012), FMEA is a set of instructions, a process, and a form to identify and prioritize potential problems (failure).

Meanwhile according to Puente et al. (2002) as quoted by Marimin et al. (2013), It was also explained that the FMEA method combines human knowledge and experience to: (1) identify potential failures of a product or process, (2) evaluate the failure of a product or process and its impact, (3) help the engineer to take corrective or preventive actions, and (4) eliminate or reduce the possibility of failure.

The FMEA method is very helpful and easy to use to identify and measure the risk of occupational accidents. Measurement of work accident risk level with conventional FMEA method is based on three parameters Severity (S), Occurance (O), and Detection (D).

III. METHOD

A. Types of Research

In this study the quantitative method is used because the FMEA method used in this study requires prior work accident data. While qualitative research methods are used because of the opinions of respondents in filling out the questionnaire.

B. Primary Data

In this case, researchers collected data by interview and gave questionnaires. The questionnaire data was obtained from 4 respondents, consisting of 3 internal people from the company laboratory and 1 external person with the same experience and education.

C. Secondary Data

In this case the secondary data used is risk identification data, company documentation, reference books, and other information related to research.

D. Data Processing and Analysis Methods

➢ *Severity*

Severity failure mode shows the level of seriousness resulting from a failure mode shown in ranks 1 to 10 which shows the level of seriousness or danger posed. Determination of the scale based on the standard Incident Severity Scale, in this scale clearly defined regarding injuries, illnesses, social and psychological hazards, as well as hazards to equipment or machinery. Determination of the scale is obtained from the results of discussions and interviews with 3 people from the company laboratory and 1 person from external who has experience and education accordingly. Then test the validity and reliability testing.

Level	***Severity***
10	Very dangerous / serious
9	Seriously
8	Very high
7	Height
6	Medium
5	Low
4	Very low
3	Minor
2	Very minor
Level	***Severity***
1	There is no effect

Table 1:- Scale of Severity FMEA
Source : (Sellappan & Palanikumar, 2013)

➢ *Occurance*

Occurrance is a frequency of the specific cause of failure of a project that occurs and results in a form of failure. Occurance uses an assessment form on a scale of 1 (almost never) to 10 (almost always). Then the reliability test and validity test.

Level	***Occurance***
10	Almost always
9	Very often
8	Often
7	Quite often
6	A little often
5	Rarely
4	A little rare
3	Quite rare
2	Very rarely
1	Almost never

Table 1:- Scale of Occurance FMEA
Source : (Sellappan & Palanikumar, 2013)

➢ *Detection*

Detection is a measurement of the ability to detect or control failures that can occur. Detection uses assessments

on a scale from 1 to 10. An assessment of the level of ability to be detected is based on Sellappan & Palanikumar (2013). Then the reliability test and validity test.

Level	***Occurance***
10	Almost impossible
9	Very difficult
8	Difficult
7	Quite difficult
6	A little difficult
5	Just ordinary
4	Easy enough
3	Easy
2	Very easy
1	Almost certainly

Table 2:- Scale of Detection FMEA
Source : (Sellappan & Palanikumar, 2013)

➢ *Calculation of Risk Priority Number (RPN)*

This step aims to obtain a sequence of importance of failure mode in the FMEA method, the importance level analysis is calculated using a Risk Priority Number (RPN).

$$RPN = Severity \times Occurrence \times Detection$$

IV. RESEARCH RESULT AND DISCUSSION

A. Types of Work Accident Hazards

Based on observations that have been made regarding the work accident process at PT. X, then categorizing the types of hazard in each type of activity in the Laboratory is carried out.

No	Activity Type	Danger Type
1	Titration	-Chemical Spill
		-The Glassware Broke
2	Preparation in acidic rooms	-Inhaling harmful gas fumes
		-Chemicals In Contact With Skin / Eyes
		-Narrow Preparation Space
3	Preparation of analysis on a lab table	-Inhaled chemicals
		-Spilled Chemicals
		-The Glassware Broke
4	Sampling udara	-Heavy load
		-Sunlight
No	Activity Type	Danger Type
5	Pipetted the solution	-Chemical spills / spills
6	Weigh chemicals	-Inhaled chemicals
		-Spilled chemicals
7	Use of the furnace and oven	Hot iron twitch
8	Disposing of the analysis result waste	-Heavy load
		-Spilled waste
		-Hit by a waste spill
9	Media pouring in order	Spills to heat

Table 3:- Table of Danger Types for Each Type of Activity

B. Severity

No Question	Respondent				R Table	R Calculate	Average	Status (R table < R count)
	1	2	3	4				
1	5	5	5	6	0,811	0,9656	5,3	Valid
2	5	5	5	6	0,811	0,9656	5,3	Valid
3	5	6	6	7	0,811	0,9386	6,0	Valid
4	5	5	6	7	0,811	0,9045	5,8	Valid
5	5	5	5	6	0,811	0,9656	5,3	Valid
6	4	4	4	5	0,811	0,9656	4,3	Valid
7	5	5	5	6	0,811	0,9656	5,3	Valid
8	3	3	3	4	0,811	0,9656	3,3	Valid
9	2	2	2	3	0,811	0,9656	2,3	Valid
10	1	1	1	2	0,811	0,9656	1,3	Valid
11	5	5	5	6	0,811	0,9656	5,3	Valid
12	5	6	6	7	0,811	0,9386	6,0	Valid
13	5	5	5	6	0,811	0,9656	5,3	Valid
14	3	4	4	5	0,811	0,9386	4,0	Valid
15	2	2	2	3	0,811	0,9656	2,3	Valid
16	3	4	4	5	0,811	0,9386	4,0	Valid
17	3	4	4	5	0,811	0,9463	4,0	Valid
18	2	3	3	4	0,811	0,9386	3,0	Valid
Total	66	72	72	91	Cronbach's Alpha Value (α) = 0,988 **Reliable**			

Table 4:- Severity Assessment Table
Source: Data processed with SPSS version 25

C. Occurance

No Question	Respondent				R Table	R Calculate	Average	Status (R table < R count)
	1	2	3	4				
1	2	3	2	2	0,811	0,8947	2,3	Valid
2	5	6	5	5	0,811	0,8947	5,3	Valid
3	3	4	3	3	0,811	0,8947	3,3	Valid
4	2	3	2	2	0,811	0,8947	2,3	Valid
5	3	4	3	3	0,811	0,8947	3,3	Valid
6	2	4	2	2	0,811	0,8947	2,5	Valid
7	8	9	8	9	0,811	0,8812	8,5	Valid
8	4	5	4	5	0,811	0,8812	4,5	Valid
9	4	5	4	5	0,811	0,8812	4,5	Valid
10	5	6	5	6	0,811	0,8812	5,5	Valid
11	5	6	5	6	0,811	0,8812	5,5	Valid
12	3	4	3	4	0,811	0,8812	3,5	Valid
13	2	3	2	2	0,811	0,8947	2,3	Valid
14	1	2	1	1	0,811	0,8947	1,3	Valid
15	3	4	3	4	0,811	0,8812	3,5	Valid
16	1	2	1	1	0,811	0,8947	1,3	Valid
17	6	8	6	7	0,811	0,9987	6,8	Valid
18	7	8	7	8	0,811	0,8812	7,5	Valid
Total	66	86	66	75	Cronbach's Alpha Value (α) = 0,982 **(Reliable)**			

Table 5:- Occurance Assessment Table
Source: Data processed with SPSS version 25

D. Detection

No Question	Respondent				R Table	R Calculate	Average	Status (R table < R count)
	1	2	3	4				
1	4	3	4	3	0,811	0,9685	3,5	Valid
2	3	2	4	2	0,811	0,9822	2,8	Valid
3	3	2	3	2	0,811	0,9685	2,5	Valid
4	3	2	4	2	0,811	0,9822	2,8	Valid
5	3	2	3	2	0,811	0,9685	2,5	Valid
6	3	2	3	2	0,811	0,9685	2,5	Valid
7	3	2	4	2	0,811	0,9822	2,8	Valid
8	3	2	3	2	0,811	0,9685	2,5	Valid
9	3	2	3	2	0,811	0,9685	2,5	Valid
10	3	2	4	2	0,811	0,9822	2,8	Valid
11	3	2	4	2	0,811	0,9822	2,8	Valid
12	3	2	3	2	0,811	0,9685	2,5	Valid
13	3	2	4	2	0,811	0,9822	2,8	Valid
14	4	3	4	3	0,811	0,9685	3,5	Valid
15	3	2	4	2	0,811	0,9822	2,8	Valid
16	3	2	3	2	0,811	0,9685	2,5	Valid
17	3	2	4	2	0,811	0,9822	2,8	Valid
18	3	2	3	2	0,811	0,9685	2,5	Valid
Total	56	38	64	38	Cronbach's Alpha Value (α) = 0,993 **(Reliable)**			

Table 6:- Detection Assessment Table
Source: Data processed with SPSS version 25

E. Calculation of Risk Priority Number

No	Activity Type	Danger Type	Risk impact	S	Causes	O	Control	D	RPN
1	Titration	-spilled chemicals	-Irritation of skin and other organs affected by spills	5,3	-Do not use personal protective equipment (PPE) -Ignore K3	2,3	-Provides PPE and first aid kit -Inspection by superiors regarding the use of PPE	3,5	42,7
		-The glassware broke	-Wounds on the skin	5,3	-The quality of the glassware is not good -Human error	5,3	-Provides good quality glassware -Work with focus and caution	2,8	78,7
2	Preparation in the acid room	-Inhaling harmful gas fumes	-Respiratory disorders	6	-Don't use PPE -Ignore K3	3,3	-Provides PPE and first aid kit -Inspection by superiors regarding the use of PPE	2,5	49,5
		-Chemicals in contact with skin/eyes	-Irritation of skin and other organs that are in contact	5,8	-Don't use PPE -Ignore K3	2,3	-Provides PPE and first aid kit -Inspection by superiors regarding the use of PPE	2,8	37,4
		-Narrow preparation space	-spilled chemicals	5,3	-Arrangement of ingredients that preparation is not good when in the acid chamber	3,3	-Record chemicals for analysis with 5R	2,5	43,7

3	Analysis preparation on the lab table	-Inhalation of chemicals	-Respiratory disorders	4,3	-Don't use PPE -Ignore K3	2,5	-Provides PPE and first aid kit -Inspection by superiors regarding the use of PPE	2,5	26,9
		-spilled chemicals	-Irritation of skin and other organs affected by spills	5,3	-Don't use PPE -Ignore K3	8,5	-Provides PPE and first aid kit -Inspection by superiors regarding the use of PPE	2,8	126,1
		-The glassware broke	-Wounds on the skin	3,3	-The quality of the glassware is not good -Human error	4,5	-Provides good quality glassware -Work with focus and caution	2,5	37,1
4	Air sampling	-Heavy load	-Injury	2,3	-Lifting the load not with an ergonomic position	4,5	-Provide training to employees on ergonomics at work	2,5	25,9
		-Sunlight	-Fatigue	1,3	-Using head protectors	5,5	-Provides PPE and first aid kit	2,8	20,0
5	Pipette the solution	Chemical spills/spills	Irritation of skin and other organs affected by splashes / spills	5,3	-Don't use PPE -Ignore K3	5,5	-Provides PPE and first aid kit -Inspection by superiors regarding the use of PPE	2,8	81,6
No	Activity Type	Danger Type	Risk impact	S	Causes	O	Control	D	RPN
6	Weighing chemicals	- Inhalation chemicals	- Respiratory problems	6	-Don't use PPE -Ignore K3	3,5	-Provides PPE and first aid kit -Inspection by superiors regarding the use of PPE	2,5	52,5
7	Use of the furnace and oven	- Chemical spill	- Irritation of skin and other organs affected by spill	5,3	-Don't use PPE -Ignore K3	2,3	-Provides PPE and first aid kit -Inspection by superiors regarding the use of PPE	2,8	34,1
		Hot iron twitch	Burns	4	-Don't use PPE -Ignore K3	1,3	-Provides PPE and first aid kit -Inspection by superiors regarding the use of PPE	3,5	18,2
8	Disposing of the analysis result waste	-Heavy load	-Injury	2,3	-Lifting the load not with an ergonomic position	3,5	-Provide training to employees on ergonomics at work	2,8	22,5
9	Media pouring in order	-Spilled waste	-Slip	4	-Slippery shoes	1,3	Provide safety shoes for employees	2,5	13,0
		-Hit by a waste spill	-Irritation of skin and other organs affected by spills	4	-Don't use PPE -Ignore K3	6,8	-Provides PPE and first aid kit -Inspection by superiors regarding the use of PPE	2,8	76,16
		Spills to heat	Damage to skin and organs affected by spills	3	-Human error	7,5	-Inspection by superiors regarding the use of PPE -Works according to SOP	2,5	56,3

Table 7:- RPN Calculation Results

V. ANALYSIS

From the Risk Priority Number analysis, it was found that three work accidents with the highest RPN level were as follows :

No	Activity Type	Danger Type	Risk impact	S	Causes	O	Control	D	RPN
1	Analysis preparation on the lab table	-spilled chemicals	-Irritation of skin and other organs affected by spills	5,3	-Don't use PPE -Ignore K3	8,5	-Provides PPE and first aid kit -Inspection by superiors regarding the use of PPE	2,8	126,1
No	Activity Type	Danger Type	Risk impact	S	Causes	O	Control	D	RPN
2	Pipette the solution	Chemical spills / spills	Irritation of skin and other organs affected by splashes / spills	5,3	-Don't use PPE -Ignore K3	5,5	-Provides PPE and first aid kit -Inspection by superiors regarding the use of PPE	2,8	81,6
3	Titration	-The glassware broke	-Wounds on the skin	5,3	-The quality of the glassware is not good -Human error	5,3	-Provides good quality glassware -Work with focus and caution	2,8	78,7

Table 8:- RPN Calculation Results

VI. CONCLUSION

Based on the results of observations, there are 10 types of work accidents that occur including accidents in the eye, inhalation of harmful gases, irritation, exposure to glass scratches, injuries of lifting heavy objects, burns, unpleasant odors, unpleasant odors, foul odors, fatigue, slipping.

From the calculation of the Risk Priority Number, it is known that there are three Failure Modes that are highlighted and should be considered, namely the preparation of analysis on a lab table with an RPN value of 126.1, piping a solution with an RPN value of 81.6 and titration with an amount of RPN of 78.7. Therefore this activity needs to get the attention of the company so that the risk of work accident can be minimized.

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