Risk Management and Control to Identify Potential Work Accidents in the Production Floor Area

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Abstract

This research was conducted at PT. X in Kalimantan is a company that produces fresh palm fruit and simultaneously produces it into Crude Palm Oil (CPO) and Palm Kernel (PK). This study aims to determine the cost of accidents using the Robinson method, determine the type of hazard risk caused to the production floor based on the Risk Matrix and provide proposals for controlling the risk of work accidents at PT. The kind of danger risk caused is based on the risk matrix 18 potential dangers that say high risk category, 8 danger risks that say moderate risk category and there are 11 danger risks that say Low risk category. X uses the Fault Tree Analysis (FTA) method. Proposed improvements

held K3 training and required workers to use PPE. Sanctioning workers not using PPE and rewards for workers who use it. Conduct supervision and hold apples every morning before doing work.

Keywords
Fault Tree Analisys, Hazard Identification, Risk Matrix, Robinson, Crude Palm Oil

1. Introduction
Pt. XYZ is a company that produces fresh palm fruit and, at the same time, makes it into Crude Palm Oil (CPO) and Palm Kernel located in the Kalimantan area. PT. X has provided all employees with the necessary Personal Protective Equipment equipment to carry out their work. PT X has also implemented an Occupational Safety and Health Management System. The program is carried out to support the safety of workers. Even though the company has implemented the Occupational Safety and Health program, PT X workers still lack self-awareness of the need for occupational safety.

Although PT. X has implemented the Occupational Safety and Health program, but work accidents happen yearly. Various efforts have been made to prevent work accidents and protect labor, including personal protective equipment. There is a reality that some workers in the production floor area still do not use personal protective equipment. Some of the workers who are not obedient in using personal protective equipment are uncomfortable because the size of the safety helmet is too large, and some confidential protective equipment material does not absorb sweat, making the workers uncomfortable using it. According to the company's data, many work accidents have occurred over the past year. This is not by the company's mission to apply the principle of zero accidents. Therefore, recommendations are needed to minimize potential hazards and risks. Here is the work accident data that can be seen in Figure 1.

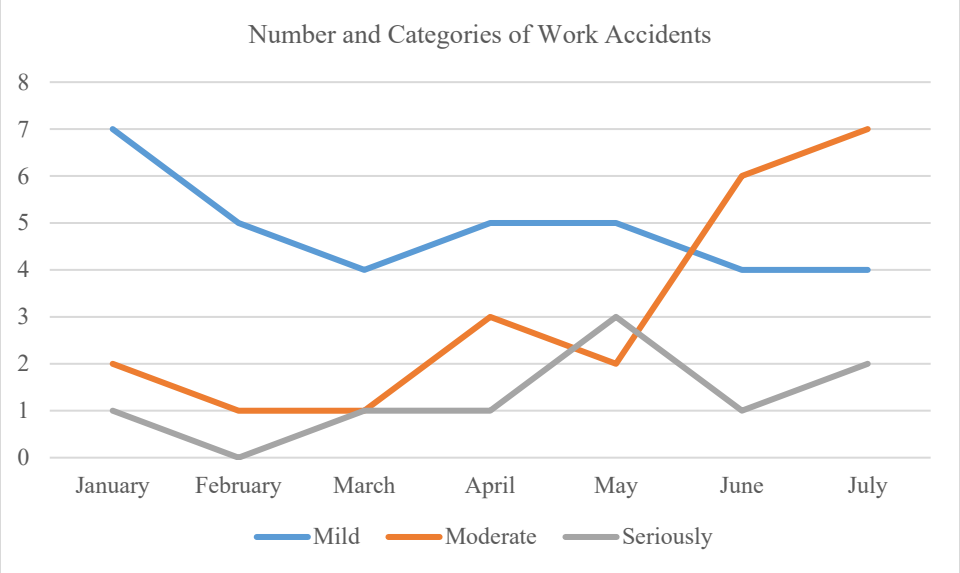

Figure 1 Number and Category Of Work Accidents

From the work accident data in Figure 1 that has been seen, it certainly hurts the company from the production target and in terms of expenses the company must bear.

This study aims to analyze the potential hazards and causes of these potentials and provide proposed improvements to reduce the risk of accidents. There are several methods, the first of which is the Hazard Identification Risk Assessment (HIRA) Method. Hazard Identification and Risk Assessment (HIRA) is one of the methods of identifying work accidents, with risk assessment as one of the critical points for implementing a safety and health management system (Falakh & Setiani, 2018; Purohit et al., 2018). The implementation of HIRA aims to identify potential hazards in a company to assess the magnitude of the chance of an accident or loss. Hazard identification, risk assessment, and control must be carried out in all company activities, including routine and non-routine activities. Direct and contract employees carry out the work, suppliers, contractors, and facility or personal activities that enter the place (Darmawan et al., 2018; Saisandhiya & Babu, 2020; Suhardi et al., 2018). How to identify hazards by identifying all

processes/areas that exist in all activities, identifying as many aspects of occupational safety and health as possible in each process / area that have been previously identified and identification of occupational safety and health carried out in a work process both in normal, abnormal, emergency, and maintenance conditions (Saisandhiya & Babu, 2020) (Prasetyo et al., 2018)(Indrawati et al., 2018).

The second method in this research is Fault Tree Analysis (FTA), the FTA method is a technique used to identify the risks that play a role in the occurrence of failure. This method is carried out with a top down approach, which begins with the assumption of failure or loss from the peak event (top event) then detailing the causes of a top event to a basic failure (root cause) (Afredo, 2021)(Anthony, 2019)(Selvakumar & Ruvankumar, 2020). Fault Tree Analysis is an effective method of finding the core of the problem because it ensures that an unwanted event or loss caused does not originate at one point of failure (Prabaswari et al., 2020)(Rajkumar et al., 2021)(Vigneshkumar & Salve, 2022). Fault Tree analysis identifies the relationship between causal factors and is displayed in the form of an error tree involving a simple logic gate(Ananto et al., 2020)(Ajith et al., 2022). Logic gates describe the conditions that trigger failures, both single and a set of different conditions (Kustono et al., 2021)(Faizan et al., 2021). So, in general, the Fault Tree Analysis method is a method of solving cases if something fails or something is not desired by looking for the root causes of basic events that arise and are described from each indication of the peak event (Top Event). This study hoped that it would minimize the number of work accidents on the production floor (Wahab et al., 2021)(Arumugaprabu et al., 2022)(Indumathi & Ramalakshmi, 2022)(Ramesh et al., 2017).

1.1 Objectives

This study aims to identify the risk of work accidents in the production floor area and determine the type of hazard risk posed to the production floor based on the Risk Matrix, Proposal for controlling the risk of work accidents using the Fault Tree Analysis (FTA) method.

2. Literature Review

HIRA (Hazard Identification and Risk Assessment) is a work program in which there is a process of recognizing hazards in a job, making hazard identification and the value of the hazard risk, and then controlling the risks and hazards that have been identified. The purpose of HIRA is to monitor the hazards that are ignored at work, even though there is a risk of accidents or health.

Hazard Identification and Risk Assessment (HIRA) is a method or technique to identify potential occupational hazards by defining the characteristics of possible hazards and evaluating risks that occur through risk assessment by using a risk assessment matrix (Rout & Sikdar, 2017), (Chung et al., 2020) Risk in general can be attributed to the probability or probability of an event occurring beyond the expected one. Risk can also be interpreted as a combination of probability and severity of damage or loss. Risk is an opportunity to lose (Risk is hance of loss) which is used to indicate a situation where there is an openness to losses or a possible loss (Hamka, 2017), (Mariawati et al., 2017). Risk is the possibility of loss (Risk of the possibility of loss) i.e. the probability of an event being between zero and one (Sreenath et al., 2020), (Panjaitan, 2017) Risk is uncertainty (Risk is uncertainty) means that risk is related to uncertainty (Sari et al., 2017), (Moniaga & Rompis, 2019). In this case, risk management is also needed as an effort to regulate the emergence of existing risks (Hafida et al., 2017). Risk management is all stages of work related to risk, including assessment, planning, handling, and monitoring of accidents (Setiawan et al., 2019), (Damayanti & Mahbubah, 2021). Related Hazard or danger is a source, situation, or action that has the potential to injure humans or physical or mental abnormalities identified as originating from and or getting worse due to work activities or work-related situations (Vishwas & Gidwani, 2017), (Athqiya et al., 2019).

The fault Tree Analysis (FTA) method is a technique used to identify risks that play a role in identifying risks that play a role in the occurrence of failure (Rout & Sikdar, 2017). This method is carried out with a top-down approach, which begins with the assumption of failure from the peak event (Top Event) and then detailing the causes of a Top Event to a basic failure (root cause) (Ragul & Sivalingam, 2021). Logic gates describe the conditions that trigger failures, both single and a set of various conditions (Ramesh et al., 2017)

3. Methods

3.1 Preliminary Studies

The preliminary study explains the flow of research carried out starting from the survey, then the collection of Data is carried out by direct observation and interviews with the company to get information about conditions in the company. The object of this research is the production process at PT X

3.2 Problem Formulation

The formulation of the problem is to clarify the issue to be researched and discussed in this study. After determining the formulation of the problem, the next step will be done to determine the purpose of the study.

4. Data Collection

In this study, the data was obtained through several methods that would later form a concrete data set and be ready to be processed.

1. Primary Data is data collected directly by researchers or without going through intermediaries by means of observation and interviews. Observation is carried out by means of direct observation of the object you want to study to obtain data that will be used in the data processing. Meanwhile, interviews were conducted interviewing workers, production assistants, and SHE PT. X the presence of potential accident hazards in the work environment.
2. Secondary Data is Data that has been available in the company, secondary Data is obtained through company records and documentation such as work accident data.

5. Results and Discussion

5.1 Hazard Identification

The results of hazard identification using the *Hazard Identification Risk Assessment* (HIRA) Method at PT. X at CPO and Kernel production process stations at each station can be seen in Table 1

Table 1 Hazard Idetification

Process	Description of Hazard's Findings	Risk
Loading Ramp Station	1. Working above Heights 2. Crushed by FFB 3. Crushed by Gancu 4. FFB Filling Chain Breaks	1. Falling from a Height 2. Bruises 3. Torn Wounds 4. Scratch Wounds
Station Sterilizer	1. Noise 2. Working above Heights 3. Operating the Tool Full of Cables 4. Slippery Floors and Stairs 5. Steam Has High Temperatures 6. Hot Steam Bursts	1. Hearing Loss 2. Falling from a Height 3. Electrocuted 4. Slip 5. Stew Tube Exploded 6. Blister wounds
Station Tippler	1. Noise 2. Stairs and Slippery Floors 3. Slammed By Brondolan Who Came Out	1. Hearing Loss 2. Slip 3. Bruises
Station Digester	1. Noise 2. Working Above Heights 3. Slippery Floors and Stairs 4. Exposed to Steam Bursts	1. Hearing Loss 2. Falling from a Height 3. Slip 4. Blister wounds
Station Press	1. Noise 2. Working Above Heights 3. Slippery Floors and Stairs 4. Exposed to Steam Bursts	1. Hearing Loss 2. Falling from a Height 3. Slip 4. Blister wounds
Station Clarification	1. Noise 2. Working Above Heights 3. Slippery Floors and Stairs 4. Exposed to Hot Oil 5. Exposed to Hot Water	1. Hearing Loss 2. Falling from a Height 3. Slip 4. Blister wounds 5. Blister wounds

Kernel Station	1. Noise 2. Working Above Heights 3. Many Transverse Heat Pipes 4. Slippery Floor 5. Inhaled CaCO3 Ingredients	1. Hearing Loss 2. Falling from a Height 3. Blister wounds 4. Slip 5. Respiratory Disorders and Poisoning
Station Boiler	1. Noise 2. Working Above Heights 3. Many Transverse Iron Pipes 4. Slippery Floors and Stairs 5. Steam with High Temperature 6. Sparks	1. Hearing Loss 2. Falling from a Height 3. Bumped Head 4. Slip 5. Exploding Boiler Tubes 6. Burns

Potential work hazards in X across all production process stations identified as many as 38 potential work hazards consisting of 8 stations as identification areas. In the identification process of the Loding Ramp Station, potential work hazards were obtained, namely 4 potential work hazards. Sterilizer stations are 6 potential occupational hazards. Trippler station is 3 potential occupational hazards. Digester stations are 4 potential occupational hazards. The Press Station is 4 potential occupational hazards. Clarification Station i.e. 5 potential occupational hazards. Kernel Stations are 6 potential work hazards, and in Boiler Stations there are 6 potential occupational hazards.

5.2 Risk Assessment

After identifying the dangers and risks contained in the production process station at PT. X, then conducted a risk assessment of the work by paying attention to two important aspects, namely severity or consequences and possibilities. The assessment of matriks risiko can be seen in Table 2.

Table 2 Assessment of Matriks Risiko

Station	**Risk**	***Severity***		***Frequency***		**Risk Rating Number**	**Index Risk of Harm**	**Priority Risk**
		Category	***Score***	***Level***	***Score***			
Loading Ramp Station	Falling from a Height	III	2	C	3	6	3C	Priority Intermediate
	Bruises	IV	0.1	D	2	0.2	4D	Lowest Priority
	Torn Wounds	III	2	C	3	6	3C	Priority Intermediate
	Scratch Wounds	IV	0.1	C	3	0.3	4C	Most Priorities Low
Station Sterilizer	Annoyance Hearing	III	2	D	2	4	3D	Priority Low
	Falling from Ketinggin	II	3	D	2	6	2D	Priority Intermediate
	Electrocuted Electricity	II	3	C	3	9	2C	Priority Intermediate
	Slip	IV	0.1	C	3	0.3	4C	Most Priorities Low
	Stew Tube Explode	I	4	D	2	8	1D	Priority Intermediate

	Blister wounds	III	2	D	2	4	3D	Priority Low
Station Tippler	Annoyance Hearing	III	2	D	2	4	3D	Priority Low
	Slip	IV	0.1	C	3	0.3	4C	Most Priorities Low
	Bruises	IV	0.1	D	2	0.2	4D	Priority Lowest
Station Digester	Annoyance Hearing	III	2	C	3	6	3C	Priority Intermediate
	Falling from Ketinggin	II	3	D	2	6	2D	Priority Intermediate
	Slip	IV	0.1	C	3	0.3	4C	Priority Lowest
	Blister wounds	III	2	D	2	4	3D	Priority Low
Station Press	Annoyance Hearing	III	2	C	3	6	3C	Priority Intermediate
	Falling from Height	II	3	D	2	6	2D	Priority Intermediate
Clarification Station	Annoyance Hearing	III	2	C	3	6	3C	Priority Intermediate
	Falling from Height	II	3	C	3	9	2C	Priority Intermediate
	Slip	IV	0.1	C	3	0.3	4C	Most Priorities Low
	Blister wounds	II	3	C	3	9	2C	Priority Intermediate
	Blister wounds	II	3	C	3	9	2C	Priority Intermediate
Kernel Station	Annoyance Hearing	1II	2	C	3	6	3C	Priority Intermediate
	Falling from Height	II	3	C	3	9	2C	Priority Intermediate
	Blister wounds	III	2	D	2	4	2C	Priority Low
	Slipping/Falling	IV	0.1	B	4	0.4	4B	Priority Low
	Respiratory Disorders and Poisoning	III	2	D	2	4	3D	Priority Low
	Hearing Loss	III	2	D	2	4	3D	Priority Low
	Falling from a	II	3	D	2	6	2D	Priority

Station Boiler	Height							Intermediate
	Bumped Head	IV	0,1	D	2	0,2	4D	Most Priorities Low
	Slip	IV	0,1	C	3	0,3	4C	Most Priorities Low
	Exploding Boiler Tubes	I	4	D	2	8	1D	Priority Intermediate
	Burns	IV	0,1	D	2	0,2	4D	Most Priorities Low

Based on Table 2 of the risk of harm caused to the production process area, there are three categories, namely the middle priority category, low priority and the lowest priority. The results of identification using the HIRA method obtained that in the production process area, there were 18 potential hazards that were categorized as medium priority.

5.2 Fault Tree Analysis (FTA)

Fault Tree Analysis (FTA) is a tree to find the causes of a system failure. The analysis of making this FTA is based on failures at production process stations where there is a highest risk matrix assessment (High risk) in PT. X. By using the FTA method, the cause of the potential danger of work accidents at PT. Inecda and will immediately get the right solution to the problem. Figure 2 is an example of Fault Tree Analysis.

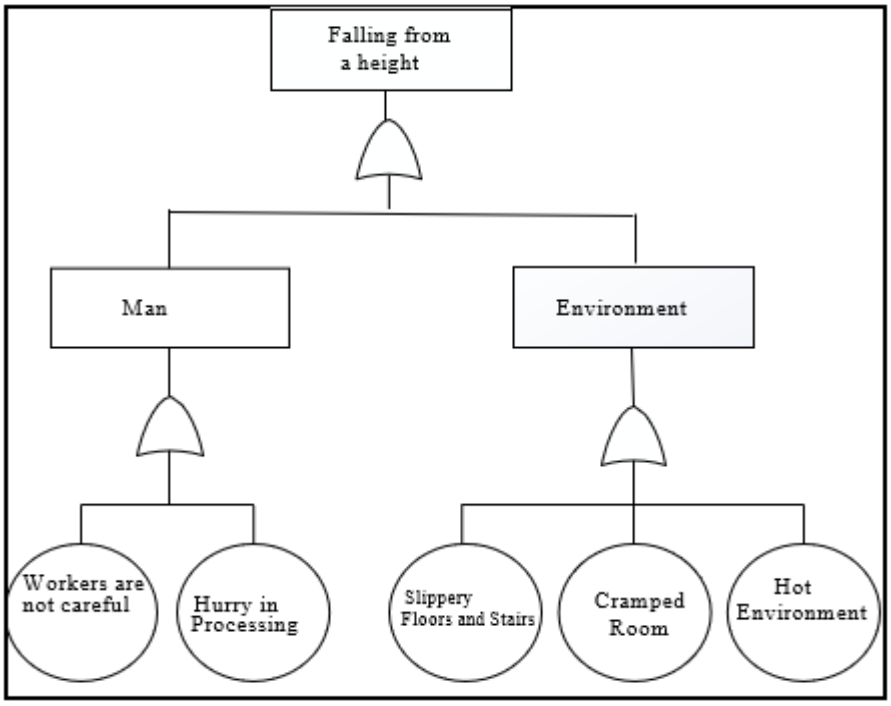

Figure 2 Fault Tree Analysis example

1. Loding Ramp Station

A. Fault Tree Analysis Dropped from a Height

The cause of falling from a height is caused by several factors, namely human factors and environmental factors. The human-caused factor is that workers are not careful when doing workers and workers carry out their work too hastily. While the causes of environmental factors are latai and slippery stairs, narrow ruagans and heat. This is what can cause potential work accidents.

B. Fault Tree Analysis torn Wounds

Torn wounds are caused by several factors, namely human factors and environmental factors. The cause of the human factor is workers who are not careful when carrying out their work and are in a hurry to do work. The work process at the Loading Ramp station is to move the TBS from the truck with a standing and slightly bent work attitude. Workers stand on the side of the truck and move the FFB using a tojok (gancu) by sorting the maturity level of the fruit and weigh more than 5 kg / bunch. Environmental factors can be caused by slippery floors, many crowds scattered on the floor this can make workers slip when entering FFB into temporary shelters and a hot work environment because workers work outdoors or open spaces, this can make workers easily tired because workers can lack fluids in their bodies due to the hot sun.

2. Sterilizer Station

A. Fault Tree Analysis Dropped from a Height

Falling from a height is caused by several factors, namely human factors and environmental factors. Factors caused by humans are that workers are not careful when doing workers, workers do not use Safety Herness which when cleaning in the sterilizer tube is carried out by the way workers climb the tube cap and only handle it on the side of the tube, lack of supervision from the company that makes workers not comply with the regulations that have been in force in the company. Meanwhile, the cause of environmental factors is slippery pants and stairs because there is residual stagnant water from environmental cleaning and steam produced from FFB decoction, narrow ruagan and heat caused by the engine, namely when boiling FFB continuously.

B. Fault Tree Analysis Electrocution

The causative factor of the problem of electric electrocution is due to human, technological and environmental factors. The human factor is caused by several factors, namely workers are not careful when carrying out their work and workers do not use PPE (Safety gloves) which functions to protect hands from electric current. The cause of the engine is caused by the lack of cable maintenance. Meanwhile, environmental factors are caused by a narrow space, operating a full machine with cables and slippery floors.

C. Fault Tree Analysis Exploding Boiled Tube

The causative factor of the problem of the boiled tube bursting is caused due to the human factor, and the machine. The cause of the human factor is that workers are not careful when doing their work, there are workers smoking in the work area due to the lack of worker awareness level, and lack of supervision. The engine factor is *steam* with high temperature, unstable pressure and the presence of leakage of the decoction pipe.

3. Digester Station

A. Fault Tree Analysis of Hearing Loss

The causative factor of the problem of hearing loss is due to human and environmental factors. Human factors can be influenced by several reasons, namely workers not using PPE (*Earplug*), lack of supervision and workers' awareness of K3 is still lacking. Environmental factors can be influenced by several reasons, namely engine sound due to the high torque of the motor engine, then there is no silencer room.

B. Fault Tree Analysis Falls from a Height

The cause of the problem of falling from a height is due to human and environmental factors. The human factor can be influenced by several reasons, namely workers are not careful when doing their work, do not use PPE (*Safety harness*), lack of supervision from the company. Environmental factors can be influenced by several reasons, namely slippery floors and stairs caused by oil droplets on the floor that
resulting from the machine, a narrow ruagan that makes the worker's movement limitations and the heat of the work environment caused by the continuous operation of the machine.

4. Press Station

A. Fault Tree Analysis of Hearing Loss

The causative factor of the problem of hearing loss is due to human and environmental factors. The human factor can be influenced by several reasons, namely workers not using Earplug, lack of supervision and workers' awareness of K3 is still lacking. Environmental factors can be influenced by several reasons, namely engine sound because the rotation of the motor engine is quite high, then there is no silencer room.

B. Fault Tree Analysis Falls from a Height

The cause of the problem of falling from a height is due to human and environmental factors. The human factor can be influenced by several reasons, namely workers are not careful when carrying out work, workers' awareness of K3 is still lacking. Environmental factors can be influenced by several reasons, namely slippery floors and stairs caused

by oil droplets on the floor produced from the engine, narrow ruagan ruagan which makes workers' movement limitations and the heat of the work environment caused by continuous engine operation.

C. Fault Tree Analysis Blister Wounds

Blistering wounds are caused by several factors, namely human factors, machine factors and environmental factors. The human factor can be influenced by several reasons, namely workers are not careful when carrying out work. The engine factor is caused by the lack of machine maintenance carried out by the management. Environmental factors can be influenced by several reasons, namely narrow ruagan which makes workers' movement limitations, slippery winding caused by oil droplets on the floor produced from the engine, very noisy engine sounds that can be causing the comfort of workers and the heat of the working environment caused by the continuous operation of the machine.

5. Clarification Station

A. Fault Tree Analysis of Hearing Loss

Hearing loss is caused due to human and environmental factors. Human factors can be influenced by several reasons, namely workers not using Earplug, lack of supervision from the management and workers' awareness of K3 is still lacking. Environmental factors can be influenced by several reasons, namely engine sound due to the high torque of the motor engine, then there is no silencer room.

B. Fault Tree Analysis Falls from a Height

Falling from a height is due to human and environmental factors. Human factors can be influenced by several reasons, namely workers are not careful, do not use Safety Herness when working at high altitudes, lack of supervision from the company, environmental factors can be influenced by several reasons, namely slippery floors caused by oil droplets on the floor produced from the engine and oil droplets on the floor, narrow noise that makes workers' movement limitations, very noisy engine sounds and the heat of the work environment caused by continuous operation of the machine.

C. Fault Tree Analysis Blister Wounds

Blistering wounds are caused due to human and environmental factors. The human factor can be influenced by several reasons, namely workers are not careful when doing their work and are too hasty when carrying out work because workers want to finish their work quickly. Environmental factors can be influenced by several reasons, namely there are hot liquids, namely oil and water in the work environment, narrow ruagans that make workers' movement limitations, slippery floors caused by oil droplets on the floor produced from the engine and droplets The oil on the floor, the sound of the engine is very noisy and the heat of the working environment caused by the continuous operation of the machine.

6. Kernel Station

A. Fault Tree Analysis of Hearing Loss

The causative factors of the problem of hearing loss are caused by human and environmental factors. The cause of the human factor is that workers do not use personal protective equipment (Earplug), the lack of supervision and awareness of workers regarding K3 is still lacking. Environmental factors can be influenced by several reasons, namely engine sound due to the high torque of the motor engine, then there is no silencer room.

B. Fault Tree Analysis Falls from a Height

The cause of the problem of falling from a height is due to human and environmental factors. The human factor can be influenced by several reasons, namely when doing their work, workers are not careful, do not use Safety Herness when working at the highest level, lack of supervision from the company. Environmental factors can be influenced by several reasons, namely slippery floors caused by oil droplets on the floor produced from the engine, puddles left over from cleaning the work environment, narrow ruagans that make workers' movement limitations, very noisy engine sounds and hot work environments caused by continuous engine operation.

7. Boiler Station

A. Fault Tree Analysis Dropped from a Height

The cause of the problem of falling from a height is due to human and environmental factors. The human factor can be influenced by several reasons, namely when doing their work, workers are not careful, do not use PPE (Safety Herness) when working at high altitudes, lack of supervision from the company. Environmental factors can be influenced by several reasons, namely slippery floors caused by oil droplets on the floor produced from the engine, puddles left over from environmental cleaning work, narrow ruagans that create limited workers' movements, and heat caused by the work environment where there is fire.

B. Fault Tree Analysis Explosion Boiler Tube

The causative factor of the problem of *the explosion of boiler* tubes is due to human, technological and environmental factors. The causes of the human factor are workers not being careful when doing their work, lack of worker awareness level, and lack of supervision from the management. The engine factor is *steam* with high temperature and unstable pressure Furthermore, environmental factors can be influenced by the presence of fire in the working environment.

6. Conclusion

The type of danger risk caused is based on the Risk Matrix 18 potential dangers that say the High risk category, 8 danger risks that say the Moderate risk category and there are 11 danger risks that say the Low risk category.

Proposed occupational accident risk control at PT. X is: Perform a thorough inspection of all components of the machine before operating the machine. Make sure all components function properly, Clean the work environment regularly which is carried out every day, K3 Training is held every 2/4 month. , Require workers to use personal protective equipment, Supervise workers in the use of personal protective equipment. If the worker violates the rules such as not using personal protective equipment, sanctions can be given and reward the worker who uses it, Apples are held every morning before doing the work done by the supervisor/foreman with the aim of reminding the worker to work safely.

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