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ANALYSIS OF POTENTIAL HAZARDS IN MACHINE MAINTENANCE USING THE JOB SAFETY ANALYSIS (JSA) METHOD : CASE STUDY PT XYZ

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Abstract

The increasing number of work accidents has recently become a global issue, especially in the cement industry. Work accidents occur due to potential hazards and potential risks in the workplace, this is a serious problem that can have an impact on worker safety and health, productivity, and operational efficiency of the company. Therefore, identification of potential hazards and control needs to be done to reduce or even eliminate the potential for work accidents and occupational diseases. This study aims to analyze and identify potential hazards and control potential hazards in machine maintenance work at the Rawmill Unit of PT XYZ using the Job Safety Analysis (JSA) method. This research is a qualitative research with a case study approach using the Job Safety Analysis (JSA) method. By using purposive sampling technique, a total of 4 informants were obtained. The data collection techniques used are observation and interviews. Data analysis used is semi-quantitative based on (AS/NZS 4360: 2004). Based on the results of the study, it is known that each stage of machine maintenance work has varying potential hazards. Through the hazard identification process, five categories of hazard factors were found, namely physical, chemical, biological, ergonomic, and psychological hazards, with a total of 31 identified hazard sources. The risk assessment results show that there are 18 potential risks at a high risk level (High Level) or 58%, 7 potential risks at a medium level (Medium Level) of 23%, and 6 potential risks at a low level (Low Level) of 19%. The most dominant potential hazards in machine maintenance work include the hazards of being pinched, crushed, electrocuted, exposed to welding flares, bumped, exposed to dust, exposed to chemicals, and broken tools that can hit the worker's body. The recommendations for control efforts that can be made are based on the control hierarchy, namely Substitution, Engineering Control, Administrative Control, and Personal Protective Equipment (PPE).
Keywords: Job Safety Analysis, Work Accidents, Machine Maintenance, Potential Hazard

Introduction

Potential hazards are an inseparable aspect of every work activity and are at risk of having an impact on the safety and health of workers. In the production process in an industrial environment, potential hazards can arise from the interaction between humans, machines, work processes, and work environment conditions. Although technological developments have resulted in more sophisticated equipment, it does not completely eliminate the existing risks. The complexity of modern tools and machinery can lead to new types of hazards if not balanced with an understanding of good work procedures and effective control systems.(1)

According to data from the International Labor Organization (ILO) in 2022, the number of cases of occupational accidents and occupational diseases in the world reached 430 million per year consisting of 270 million (62.8%) cases of occupational diseases and 160 million (37.2%) cases of occupational diseases, and caused the death of 2.78 million workers each year. 40% of cases of HH and PAK occur in young workers.(2) According to data from the Social Security Administration (BPJS) Employment,

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the number of claims for Work Accident Insurance (JKK) in 2019 was recorded at 182,835 cases. This number continues to increase from year to year, with 221,740 claims in 2020, 234,370 claims in 2021, and reaching 297,725 claims in 2022. Until the January-November 2023 period, the number of JKK claims has reached 360,635 cases.(2) According to the West Sumatra Regional Employment BPJS, in 2021 there were 31,801 cases of work accidents. This figure increased by 16.96% compared to the previous year, with 166 workers reported dead.(3)

Based on PT XYZ's work accident data, it shows that in 2020 there were 10 accidents which caused a loss of 15 working days, in 2021 there were 11 work accidents and 7 near accidents, resulting in a loss of 89 working days. In 2022, there were 10 work accidents and 3 near misses, resulting in a loss of 25 working days. The loss of working days will have an impact on workers' health, especially on psychological health. Income uncertainty and a sense of lost productivity can trigger stress, anxiety, and even depression. In addition, financial pressure due to reduced wages or job loss can also worsen mental conditions, trigger conflicts in the family, and reduce motivation to return to work. This is in line with research conducted by Ompsunggu et al, (2023), which states that the loss of work productivity and workplace health as well as compensation authority (increased work leading to an increase in major depression, anxiety disorders and stress).(4)

PT XYZ is a company engaged in the production of cement. In operational activities, especially in production processes such as raw material processing (raw mill), clinker burning (kiln), and finish mill, there are various potential hazards that can cause work accidents. Some of the potential workplace accidents identified include miscommunication between workers, the risk of being pinched by rotating machinery, scratched or crushed by materials, nudged by heavy equipment, shocked from high-voltage electrical equipment, falling from a height during inspection or maintenance, and eyes exposed to splashes of cement dust or metal chips during machine repairs. These potential hazards can cause serious injury to workers, ranging from minor injuries to serious accidents that have an impact on disrupting the production process.

One of the hazard analysis techniques commonly used in various work environments is Job Safety Analysis (JSA). This method is used to identify and analyze potential hazards that may arise in each stage of work. This approach is in line with the principle that work accidents are generally caused by unsafe conditions or actions. Therefore, by systematically identifying and analyzing hazards, more precise, measurable, and efficient preventive measures can be determined.(5)

PT XYZ has implemented the Job Safety Analysis (JSA) program as an effort to improve work safety, but its implementation in the field is still not optimal. Obstacles such as low worker understanding, uneven involvement, and inconsistency in implementation cause Job Safety Analysis (JSA) to not run effectively. Although SHE staff have compiled a Job Safety Analysis (JSA) in a planned manner, its implementation has not fully supported the creation of a safe working environment and overall accident prevention.

Based on the results of initial observations made by researchers in the machine maintenance area in the Rawmill unit of PT XYZ, several complaints from workers were found regarding the potential hazards that occurred. The potential hazards include workers experiencing electric shock, workers being hit by tools, workers experiencing exposure to dust. In addition, workers also experience exposure to spatters from welding activities. The potential hazards at PT XYZ are also found in the machine maintenance work process in the Rawmill unit of PT XYZ.

Based on the results of interviews conducted by researchers, there was a work accident in February 2024 known to have occurred an explosion when filling nitrogen gas into an accumulator tube which caused sparks. In the work accident there were 5 victims, 1 victim suffered minor bruises, 2 victims suffered 20% - 30% burns, while the other 2 victims suffered minor burns to the hands. To prevent work accidents, it is necessary to analyze and identify potential hazards to determine the risk of work accidents in the company's production process. One of them can be done by recognizing the

potential hazards that exist in the workplace by identifying potential hazards that exist in the workplace. Based on the above background, the researcher is interested in conducting research with the formulation of the problem of what are the potential hazards and control efforts for machine maintenance workers with the Job Safety Analysis (JSA) method at PT XYZ, while the specific objectives of this study are to analyze and identify potential hazards and control potential hazards in machine maintenance workers at PT XYZ.

Methods

The research method used in this research is a type of qualitative research with a case study approach that aims to analyze potential hazards using the Job Safety Analysis (JSA) method in a machine maintenance work process at PT XYZ. This research wants to describe the potential hazards that exist at PT XYZ and assess the potential risk of work accidents that may occur in the company. This research was conducted at the Rawmill unit of PT XYZ from July to November 2024. In determining the subject of this study, purposive sampling was taken. The inclusion criteria in this study are workers aged ≥ 30 years, not in a sick condition, permanent workers who work at PT XYZ, working period ≥ 10 years and willing to be respondents. In this study, the informants consisted of 1 key informant, namely the foreman, 2 main informants consisting of 1 supervisor and 1 worker, and 1 supporting informant, namely SHE staff. The data collection techniques used were observation and direct interviews with informants. Researchers made observations using the Job Safety Analysis (JSA) instrument by detailing the stages of work carried out to provide control of potential hazards. In addition to using primary data obtained directly from informants, this researcher also used secondary data in the form of a review of company documents to further enrich the research information.

The Job Safety Analysis (JSA) method is a way to identify hazards in the work environment as well as control and countermeasure efforts to prevent occupational accidents and occupational diseases that may arise from a job.(6)) In analyzing the potential hazards of work using Job Safety Analysis there are four basic steps, namely:

1. Determine the work to be analyzed.
2. Decompose the work into basic steps.
3. Identifying hazards or work accidents in each job. Hazards that are included in the work environment include:
    a. Physical Hazards (e.g. noise, heat, lighting, radiation, air pressure, vibration, height, and electricity).
    b. Chemical Hazards (e.g. toxic materials, flammable and explosive materials)
    c. Biological Hazards (e.g. viruses, bacteria fungi harmful animals and plants)
    d. Ergonomic Hazards (e.g. work that violates or is not in accordance with the posture or function of the worker's body that will cause disease)
    e. Psychological Hazards (e.g. worker's attitude or behavior, emotional level).
4. Controlling hazards in an effort to prevent work accidents. Hazard control efforts that can be carried out are using a hierarchy of control controls consisting of Elimination, Substitution, Engineering Control, Administrative Control, and Personal Protective Equipment (PPE).(7)

The results of the data that has been obtained will then become an assessment material to determine the level of risk according to the type of work. From these potential hazards, a potential hazard assessment is carried out using the risk assessment hazard identification procedure. Hazard identification is a systematic effort to determine the presence of hazards in organizational activities.(8) In other words, hazard identification is the process of analyzing the sources of danger arising from a work activity that is determined based on hazard factors.

After identifying hazards, risk assessment is the data analysis step. This research data analysis uses semi-quantitative techniques based on guidelines from the Australian/New Zealend Risk Management standard (AS/NZS 4360:2004), which is an Australian standardization. The purpose of this stage is to determine the level of risk or hazard that has been previously known. The risk value is calculated with two parameters, namely: probability/likehood of hazard and severity of hazard. The risk value can be calculated using the following formula: Risk = Likehood x Severity = Risk Level. The results of likehood and severity will be used to determine the risk level. The highest risk level will be the top priority for implementing appropriate controls to reduce or even eliminate cases of occupational accidents and occupational diseases.(9) In conducting a hazard risk assessment using the semi-quantitative analysis method, there are two main elements that are taken into consideration, namely the probability/likhood of hazard and severity of hazard. These two elements are used to determine the level of risk, so that it can be used as a basis in setting priorities for hazard control in the work environment:

1. **Probability/Likehood**

   The possibility of an accident or loss due to exposure to a hazard is referred to as risk, as explained in the AS/NZS 4360:2004 standard. The likelihood can be assessed using a rating system, which is shown in the table below.

Table 1. Parameters probability/likehood of hazard

Level	Category	Description
1	Very Small	Occurs 1 x in more than 1 year
2	Small	Occur 1 x in 1 year
3	Medium	Occur 1 x in a month
4	Large	Occur 1 x in a week
5	Very Large	Occurs almost every day

Source: standard AS/NZS 4360:2004

2. **Severity**

   Severity is an assessment of the severity of the impact caused when a hazard occurs. This means that each impact will be evaluated based on how serious or severe the consequences are for safety, health or other losses. This severity assessment is expressed in the form of a Severity (S) rating, which can be seen in the table below.

Tabel 2. Parameters severity of hazard

Level	Category	Description
1	Very Mild	No injury, small financial loss
2	Mild	Minor injury, minor financial loss
3	Medium	Moderate injury requiring medical treatment, substantial financial loss
4	Heavy	Serious injury to one or more persons, substantial loss and interruption of production.
5	Very Heavy	The death toll is 1 or more people, the loss is very large, disrupting the entire process of company activities, the impact is very broad and comprehensive.

Source: Standard AS/NZS 4360:2004

From the two parameters above, it will then display the risk assessment matrix level. The assessment is determined based on historical data of work accidents then multiplied by the losses suffered. The results of the risk assessment are needed to determine the risk level of each potential risk.

3. Risk Assessment

Risk assessment is an assessment process used to identify potential hazards that may occur. With the Risk Assessment rating assessment can be seen in the table below:(10)

Table 3. Risk Assessment Matrix

Probability/ Likehood Of Hazard	Severity Of Hazard				
	Very Mild	Mild	Medium	Heavy	Very Heavy
Very Small	1	2	3	4	5
Small	2	4	6	8	10
Medium	3	6	9	12	15
Large	4	8	12	16	20
Very Large	5	10	15	20	25

Sumber: Standar AS/NZS 4360:2004

Based on the risk assessment obtained, it is then converted into a risk level indicator table with the intention of knowing which category the potential hazard falls into. The following below is a table of risk level indicators.

Table 4. Indication of Risk Level

Risk Level	
1 - 4	**Low**
5 – 9	**Medium**
10 – 16	**High**
≥ 17	**Extreme**

Source: Standard AS/NZS 4360:2004

After knowing the level or risk level of each potential hazard found, the next step is to carry out risk control. This control aims to eliminate or minimize the possibility of work accidents.

4. Risk Control

Risk control is a way to overcome the potential hazards contained in the work environment. These potential hazards can be controlled by determining a top priority scale first. Risks with the highest level will be the top priority for appropriate control to prevent or even eliminate cases of work accidents and occupational diseases.(10)

Result

Based on the results of observations using risk analysis in the machine maintenance process at the Rawmill unit of PT XYZ, potential risks were found that could arise in each sequence of work. Identification of potential hazards is carried out by evaluating various aspects of the workplace, such as the work environment, equipment or machinery used, materials used, and labor conditions. The goal is to find and recognize hazards that may exist in the workplace. Once the hazards are identified, control measures will be implemented to reduce or eliminate the risk. This is important so that potential hazards do not develop into work accidents, which can cause material loss, property damage, injury, or even fatalities to the workforce. To identify a potential hazard what must be done is to describe the types of work and stages of work carried out in machine maintenance at the Rawmill Unit of PT XYZ.

What types of work are carried out during machine maintenance in the Rawmill unit

Based on the results of interviews and direct observations in the field, it is known that the machine maintenance process at PT XYZ involves a number of technical activities that are quite complex and crucial. This is due to the many machine components that experience wear and tear due to the high intensity of use during the production process. These components play an important role in supporting the smooth and safe operation of the factory, so they need special attention in the maintenance process. The following is a statement from an informant describing this condition:

> "*It depends on the type of machine maintenance, whether it is routine maintenance, or specific time maintenance, there is also machine maintenance when damage occurs and before damage occurs. So the work done depends on the type and timing of the machine maintenance." (**key informant)***

The foreman's statement is also supported by the statements of supervisors and workers.

> "*The work carried out during maintenance is the most important, we usually repair worn components because it has the most influence when the machine is operating." (**Key Informant 1)***

Meanwhile, workers stated,

> "There *are various kinds of work carried out, starting from replacing worn roller tables, replacing worn scrapper mills, installing clim ping rollers, repairing water injection, replacing leaking sill rollers, repairing worn safety hard rollers, usually our last job is cleaning the body." **(Key Informant 2)***

Some of the machine maintenance work processes can be seen from the table below:

Table 5. Types of work and stages of work at PT XYZ Rawmill Unit

No	Type of work	Stages of work
1	Rotor Stator Insert Plate Repair	Check and wear Personal Protective Equipment (PPE) and ensure the work area is safe
		Prepare equipment and tools
		Turning the power off the electricity
		Lifting goods using a hoist crane
		Replace or install rotor stator insert plates in confined spaces.
2	BHF Fan Bearing Replacement	Perform material transport
		Loosen the bearing housing bolts and remove the old bearing
		Remove the old bearing
		Installing the new bearing
		Re-lubricating the new bearing
3	Segment Roller Replacement	Perform material transport
		Lift the segment roller using a hoist crane
		Unbolt the segment roller
		Move the new segment to the new roller and lock it

Source: PT XYZ

The next step in the *Jobs Safety Analysis* (JSA) is to identify hazards to find out the sources of danger or hazards that arise when doing a job.

Sources of hazard that can occur during machine maintenance in the Rawmill Unit

Based on the results of interviews and observations in the field, it is known that the machine maintenance process in the Rawmill Unit of PT XYZ contains various potential hazards originating from working conditions, equipment, and the environment around the work area. These sources of hazards arise as a result of the characteristics of work that involve direct contact with machines and mechanical components that have high risks. Based on informants' information, there are various sources of hazards that are often encountered during machine maintenance activities.

> *"The sources of danger are quite many and varied, because maintenance work involves mechanical, electrical, and work environment areas. For example, the heat from cutting tools such as the grend can cause burns and eye irritation due to the splinters. Then from the vibration of the awl or drill, it can disturb the nervous system or muscles. Workers who enter a narrow area or confined space that lacks lighting and air circulation are certainly very disruptive to the work process." (**Key Informant)***

This statement was reinforced by the supervisor who observed that sources of danger are still often found in the work environment.

> *"The hazards can be from work tools, such as grinders and drills, which have high vibrations and can injure hands. In addition, sometimes the narrow working position makes the body tired quickly or easily bumped, pinched. Hot engine temperatures and dust can also interfere with breathing and scattered tools or oil spills can also be a source of danger. That's why we have to be careful about all that. (**Key Informant 1)***

Meanwhile, from the perspective of workers directly in the field, the sources of danger were felt to be physically and personally closer, stating.

> *"I am most afraid of electrical repairs, because I have experienced electric shocks, so I am traumatized. Sometimes working in a narrow area makes it difficult to move and it is easy to get pinched or bumped and the work becomes much more difficult. Sometimes the residual cement dust also makes me congested, coughing, and makes me dizzy. (**Key Informant 2)***

The following is a hazard identification table:

Table 6. Hazard Identification

No	Hazard Factor	Emerging hazard Source
1	Physical	Insufficient lighting in the confined space work area Hot temperature from welding work Vibration generated by the use of electric tools such as drills or grenda Wet floor due to scattered water, and slippery floor due to oil spills Dust form material that remain on the walls of the Rawmill Unit
2	Chemical	Use of chemicals in the form pf lubricants
3	Biology	Aspergillus fungi found in dusty environments
4	Ergonomics	Workers often have to bend over, reach into difficult areas, or work in a squatting Position when repairing or cleaning machines Poorly lit, cramped work areas

5	Psychology	Loss or working days due to work accidents Pressure from superiors Excessive workload Excessive working hours

Source: PT XYZ

The next step after identifying hazards is to conduct a risk assessment, determine the level of risk, and prioritize the machine maintenance work in the Rawmill unit from each source of danger that arises.

Risk assessment, risk level determination, and prioritization of machine maintenance work in the Rawmill Unit

Based on the results of interviews with several informants and direct observations in the field, it is known that in machine maintenance activities in the Rawmill Unit of PT XYZ, determining the risk level and priority scale of work is carried out systematically. This is important considering that maintenance work often involves high hazards, limited work areas, and tight time pressure during the repair period. Therefore, risk-related decision-making is one of the main aspects in maintaining work safety. The key informant explained that risk assessment is carried out by referring to the HIRADC *(Hazard Identification, Risk Assessment, and Determining Control)* method and the risk assessment matrix from the SHE unit. In his statement, he mentioned:

> *"We determine the risk level from two things: how often the hazard is likely to occur and how severe the hazard is. For example, if a worker is lifting a segment roller using a hoist crane, if the worker is not careful and the worker's position is not safe, we immediately categorize it as a high risk of being pinched. And from there we can determine whether it should be stopped, postponed, or continued with strict control or supervision. We also prioritize even though the work is small but the risk is high, it must still be prioritized because it can interfere with work operations. (**Key Informant)***

This statement is in line with the supervisor's statement that the priority scale depends on the risk value obtained at the beginning:

> *"We have a HIRADC (Hazard Identification, Risk Assessment, and Determining Control) form and a JSA (Job Safety Analysis) form. Where we use HIRADC to identify potential hazards throughout the work area in which there is already a risk assessment matrix. And we use JSA to identify potential hazards with high risks at each stage of work. JSA must be filled in directly in the field and before work begins because from there it can be seen which jobs are included in high risk. If the HIRADC form has a red score, then it must be prioritized and done with full supervision. The yellow ones can be continued with additional controls, while the green ones are relatively safe." (**Key Informant 1)***

Meanwhile, workers also understand that the determination of work priorities depends on the potential hazards, stating:

> *"If we see that the work is dangerous, for example working in a narrow and dark space, we will report it first before continuing to work. Usually the foreman decides. And because we have a lot of experience from previous work accidents, we also know which work is more risky, so we are more careful, always wear complete PPE and always attend briefings first." (**Key Informant 2)***

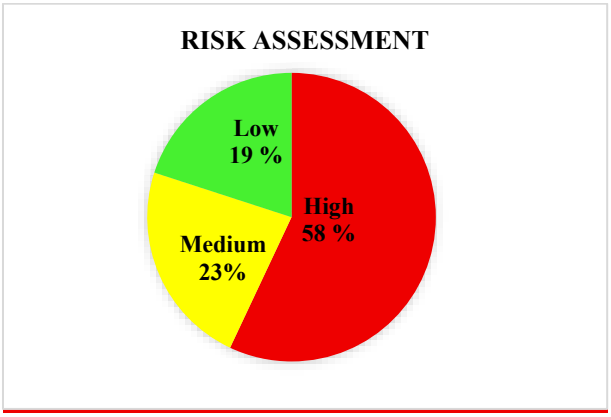
At this stage the author will determine the potential hazards and potential risks of each source of danger, and then will conduct a risk assessment in accordance with the guidelines of the *Australian Standard/New Zealand Standard for Risk Management* (AS/NZS 4360: 2004) which is a standardization from Australia. There are 2 parameters that are used as a measurement of risk value, namely probability/likelihood of hazard and severity of hazard. The following is a risk assessment table:

Table.7 Risk Assesment

Stages of Work	Potential Hazard	Risk Assessment			
		L	S	Risk Value	Risk Level
Checking and wearing PPE and ensuring the work area is safe	Error in selecting PPE	2	1	2	Low
	PPE that is damaged and unfit for use	3	1	3	Low
Prepare equipment and tools	Tripping over tools or cultter	3	2	6	Medium
	Getting stuck when picking up tolls	4	3	12	High
	Being crushed when picking up tools	2	4	8	High
Turning power off electricty	Electrocution	3	3	9	High
Lifting goods using a hoist crane	Pinched strongly binding goods	2	4	8	High
	Bumped when lifting goods	2	3	6	Medium
	Struck by the rotor stator due to incorrect binding of the lifting rope	1	5	5	Medium
Replacing or installing rotor stator insert plate in confined space	Falling on the rotor stator when removing it from the hoist crane	3	4	12	High
	Bumped while installing rotor stator	3	3	9	High
	Pinched when installing the rotor stator	2	2	4	Low
	Exposed to welding flare	4	3	12	High
	Exposed to high pressure gas expolosion	5	1	5	Medium
Transporting materials	Exposure to material dust	5	3	15	High
Loosen the bearing housing bolts and open the old bearing	Pinched when removing the bolt	3	3	9	High
	Sturck by a bearing	2	3	6	Medium
	Scratched when opening the bearing	2	2	4	Low
Removing old bearings	Impacted bearing	3	3	9	High
	Pinched when removing the bearing	3	3	9	High
	Scratched when removing bearings	2	2	4	Low

Installing new bearings	Pinched during bearing intallation	3	3	9	High
	Falling on the installation tool	3	3	9	High
Re-lubricant a new bearing	Exposure to lubricant chemicals	3	3	9	High
Transporting materials	Exposure to dust	5	3	15	High
Lifting segment roller using a hoist crane	Pinched while tying the rope on the roller segmet	3	3	9	High
	Being crushed by the roller segment if the binding is not correct	4	1	4	Low
	Tools break and hit the body	5	2	10	High
Unscrew roller segment bolt	Pinched when unscrewing the roller segment bolt	3	2	6	Medium
Move the new segment to the new roller and lock it up	Overwhelmed while moving the new segment	3	4	12	High
	Scratched while locking a new roller segment	2	3	6	Medium

Based on the results of the risk assessment that has been carried out on the machine maintenance work process at PT XYZ, a total of 31 potential risks are obtained with the following details: 6 potential risks are in the *low* risk category, 7 potential risks are in the *medium* risk category, and 18 potential risks are in the *high* risk category. These results indicate that most of the potential hazards identified have a level of risk that requires further attention and control so as not to cause work accidents.



Graph 1. Risk Assessment

The high risk level (high) is the top priority in implementing control measures, given the magnitude of the impact that can be caused to work safety. Based on the results of the risk assessment at PT XYZ, the distribution of risk levels is as follows: 19% are in the low risk category, 23% are in the medium risk category, and the majority, 58%, are in the high risk category. This percentage shows that more than half of the identified potential hazards are at a high risk level, so effective and immediate control efforts are needed.

After the risk assessment process is completed, the next step is to implement risk control. Risk control aims to minimize or manage potential hazards that can occur in the workplace. Risks that have the highest severity or likelihood of occurrence will be prioritized to be controlled first. This is done by

applying appropriate control measures such as elimination, substitution, engineering, administration, or the use of personal protective equipment (PPE).

Strategies for controlling potential hazard in machine maintenance at the Rawmill Unit

Based on the results of interviews and direct field observations, it is known that the process of controlling potential hazards in machine maintenance in the Rawmill Unit of PT XYZ is carried out through a multilevel approach that refers to the principle of the hazard control hierarchy. The control is designed to adjust the characteristics of each type of hazard posed. Key informants explained that control is carried out based on the results of a previously established risk assessment, prioritizing elimination, substitution, and engineering before using administrative control methods to the use of personal protective equipment (PPE). Yang stated that:

> *"Control depends on the level of danger. If it can be eliminated, we eliminate it but no source of danger can be eliminated. Because they cannot be eliminated, we modify the work system or use assistive devices. For example, if workers have to enter a narrow work area, we make sure blowers are available, install gas detectors, and workers wear safety hurness. We also always make sure all work tools are checked before use. We always require a briefing or safety talk before work begins, check that PPE is complete, and all work must be in accordance with the JSA. If it is not, we will give a warning or stop work until it is safe" (**Key Informant)***

Meanwhile, the supervisor stated that control is carried out based on the most dominant type of hazard.

> *"For physical hazards such as heat and vibration, we make sure workers use special PPE such as heat-resistant gloves and earplugs. For work tools such as grenda and drills, we check them before use and always install guards. For slippery floors, we give a visual warning and dry them before starting work." **(Key Informant 1)***

In addition, workers also have an active role in implementing hazard control, especially those that are direct and practical in the field, stating:

> *"Usually we start with a safety talk to remember to work safely and securely, check the complete PPE, such as helmets, glasses, safety shoes, gloves and body vests. We also try to work in safe conditions, and our behavior is also safe so that we avoid work accidents. (**Key Informant 2)***

In this way, it is hoped that the risk of work accidents and occupational diseases can be minimized or even eliminated, thus creating a safer and healthier work environment for all workers. The following is a table of risk control:

Table 8. Risk Control

Risk Control			
Potential Hazard	**Risk**	**Impact**	**Control**
Erroring in choosing PPE	Miss communication or not knowing the work direction	Unable to work	Every worker must participate in a safety talk or toolbox meeting
Damaged or unfit for use PPE	Miss communication not knowing the work direction	Unable to work	Every worker must participate in a safety talk or toolbox meeting
Tripping	Sprains, bruises, internal injuries	Muscle pain, internal injuries	Make sure there are no scattered objects on the road
Pinched	Bruisess, open	Nerve, muscle and blood	Wear appropriate gloves or body

	wounds, bleeding, fracturs	vessel damaged, permanent disability	armor the reduce the risk of injury and be sure to reduce direct interection on hazardous work
Struck	Fractures, bruising, bleeding	Permanent disability, swelling, damaged to muscle tissue and nerves	Wear appropriate personal protective equipment and ensure materials and tools are properly stored so they do not fall on workers below
Electrucution	Burns, tissue damage, loss of consciousness	Numbness, permanet nerve damage, heart rhythm disturbances (arrthythmia)	Make sure electrical power is turned off, install lototo, replace electrical equipment that is damaged or does not meet standards
Bumping	Bruising, bleeding	Swelling, internal bleeding	Change the layout of the work area, install safety signs, use safety helmets, safety shoes
Exposed to welding flare	Eve injury, burns	Red eyes, pain, skin blistering, irritation or inflammation	Use a special welding helmet, use heat-resistant gloves, wear a body vest or warepack
Exposure to high pressure gaas explosion	Gas poisoning, burns, injuries from debris	Respiratory distress, permanent disability	Install a pressure relief valve to prevent over-pressurization of gas cylinders, place gas cylinders away from sources of heat or flame.
Exposure to dust	Respiratory distress, eye and skin irritation, onset of occupational disease	Respiratory tract irritation, red eyes dry skin, lung disease	Wear a mask, eye protection, gloves, body vest or warepack, conduct periodic health checks
Scartchles	Bleeding wound, inflammation	Infection, pain in the wound area, damage to nerve and muscle tissue	Use protectors or covers on sharp parts of tools or machines. Provide safe storage of sharp tools.
Chemical exposure	Irritation, burns, poisoning	Redness, itching, loss of consciousness	Wear specialized or chemical- resistant gloves, use face shields, safety shoes, and clean the body thoroughly to prevent excessive contamination
Tools break and hit the body	Bruises, bleeding wounds, broken bones	Swelling, bleeding, infection, permanent disability	Regular inspection of work tools to detect damage before use. Using tool protectors such as casings or shields to prevent debris from being thrown Placing workers at a safe distance when using tools that are at risk of breaking.

Discussion

Based on the results of the identification of potential hazards and hazard risk assessments that have been obtained and analyzed using the *Job Safety Analysis* (JSA) method, many potential hazards are found from each stage of the machine maintenance work process such as errors in choosing PPE, damaged or inappropriate PPE, tripping, to being exposed to high-pressure gas explosions. While the potential hazards with a risk level of "High" that often arise will be the top priority to be addressed and implemented controls are the potential hazards of being pinched, crushed, electrocuted, exposed to welding flares, bumped, exposed to dust, exposed to chemicals, tools broken and hit the body which can harm workers, harm the production process, and company productivity.

The potential pinched hazard is a top priority potential with a risk level of "High" which has the most potential to occur. Pinching is a hazard that falls into the high risk category, especially in work environments involving moving or rotating machinery. For example, in the work of tying goods weighing ≥ 50 tons, there is a potential pinch hazard that can occur if workers are too close to the load during the tying process or when the straps suddenly pull, break, or shift due to load imbalance. This potential hazard can result in serious injuries, such as broken bones, amputation, or even death. Despite this, awareness of these hazards is often not considered urgent enough, even though the impact can be fatal. In a study conducted by Wisnugroho, et al (2024), it was stated that "the potential hazards of hands and feet being pinched by pallets and conveyors have the potential to have severe (critical) injury severity, namely accidents that cause injury or severe pain for a long time unable to work or cause permanent disability".(11) This is in line with the research of Putri and Widjajati, (2021), also stated "In the work of using a Radial Arm Saw cutting machine, especially at work stages such as adjusting the arm up and down and locking the arm, there is a potential danger of pinching the hand or finger due to an unsafe position when operating the lever. This condition can cause serious or fatal injuries if not done with the correct procedure. Consequences that can occur include bruised hands or knuckles and peeling of hand skin."(12) The control that can be done to control these risks is for the company to provide appropriate gloves or body protection to reduce the risk of injury and ensure to reduce direct interaction on dangerous work.

Furthermore, the potential hazard with the highest priority is being crushed which can result in various serious injuries such as fractures, lacerations, bruises, and death. For example, in work that involves lifting tools or goods using a hoist crane, there is the potential danger of being crushed if the goods being lifted are not properly tied or there is a failure in the lifting equipment and the worker is not in a safe position. This can cause serious to fatal injuries to workers who are under or around the lifting area. In a study conducted by Aziz et al, (2022), which states that "workers while at height have potential hazards that can arise very much and the risks that occur are also very fatal can cause death due to working above height and being hit by scaffolding material."(13) This is also in line with research conducted by Robawa and Szs, (2025) stating that "In work related to the cleanliness and tidiness of the work area, the condition of equipment that is not well organized or scattered can pose potential hazards such as being hit by equipment or colliding with work objects. This situation not only jeopardizes worker safety, but can also disrupt the smooth running of operational activities."(14) The control that can be done is that workers must wear personal protective equipment correctly and appropriately and ensure that materials and tools are stored properly so that they do not fall on workers, and workers must always work in a safe position.

The next potential hazard with top priority is electrocution. Electrocution is a condition in which the human body experiences direct contact with a source of electrical voltage, which causes electricity to flow through the body. This can happen when a person comes into contact with exposed electrical wires, unsafe electrical equipment, or other sources of electricity. For example, in electrical repair work that is short-circuited or in conditions of open electrical cables, there is a potential danger of electric shock. This risk can occur if workers make direct contact with electric current without

adequate security or without turning off the electrical power. Electrocution can result in a variety of serious impacts, depending on the magnitude of the voltage and the duration of exposure to the electric current."(15) The risk of burns is one of the causes of temporary, permanent disability, and death caused by potential electrocution hazards. In research conducted by Rahmanto and Hamdy, (2022), which states that "the potential hazards that arise are included in the category of very high risk (extreme) because the impact that arises is electrocuted with high voltage so that it causes burns due to electric shock and even death can occur."(16) This is in line with research conducted by Ariyani et al, (2021) which states that "The potential danger of electric shock can arise due to lack of vigilance and limited knowledge of workers in carrying out work procedures. This can lead to the implementation of work that is not in accordance with safe work procedures, thereby increasing the risk of work accidents, even causing fatalities."(17) Controls that can be carried out are workers must ensure that the electrical power has been turned off to prevent work accidents, lototo installation needs to be done so that no workers are careless in turning on the electricity, replacing electrical equipment that is damaged or does not meet standards in order to minimize the occurrence of work accidents and replacing high- voltage electrical equipment with low-voltage electrical equipment.

Welding work is an activity that has high potential hazards such as being exposed to welding flares that can result in various risks, such as physical injury, fire, or health problems. Hazards that often arise include exposure to ultraviolet light that can damage the eyes, sparks that risk starting a fire, exposure to toxic fumes that harm the respiratory system, and the risk of electric shock or burns from improperly used equipment.(18) In research conducted by Septiani and Noverly, (2024), which states that "Hand and foot burns due to welding sparks are a serious risk often faced by welding workers. Welding sparks can reach very high temperatures and are capable of causing burns, ranging from first, second, to third degree, depending on the intensity and duration of exposure. These burns not only cause severe pain, but can also lead to tissue damage, infection, or even permanent disability if not treated appropriately."(19) This is in line with research conducted by Rosadah et al, (2024) which states that "Welding work can have a very detrimental impact on workers, such as exposure to ultraviolet and infrared radiation, inhalation of fumes in welding, fire, and electric shock."(20) The control that can be done is that workers must use special welding helmets, use heat-resistant gloves, wear body vests or warepacks that can prevent work accidents.

In addition to this, bumping is also a top priority risk that can result in physical injuries, such as bruises, cuts, or even fractures, as well as damage to surrounding equipment or materials. For example, when replacing or installing a rotor sttor insert plate in a confined space. With a limited work area, it is difficult for workers to move freely so that the potential danger of colliding with work tools is very large. This risk often occurs in crowded, cramped, or less organized work environments, especially when workers move around hard objects, machinery, or protruding structures. In a study conducted by Ghika Smarandan et al, (2021), which stated that "The potential danger in the stamping section is being hit by the stamping machine body because the distance between the machines is only 90 cm. The operator's movement is slightly limited due to the narrow space and there are raw materials scattered on the floor which can cause workers to hit the machine body or cut their hands".(21) This is in line with research conducted by Bastuti and Th, (2021) which states that "At the stage of work to lower the cylinder after the lifting process with a hoist crane, there is a potential hazard in the form of hitting the head of the cylinder or the cylinder falling. This condition can cause serious injuries such as head injuries, leg injuries, and fatality risks if not carried out with safe work procedures and appropriate tools."(22) The controls that can be carried out are redesigning the layout of the work area to eliminate cluttered objects that have the potential to cause bumps. Install safety signs, and use complete personal protective equipment according to the job.

The next potential hazard with the highest priority is dust exposure. Continuous exposure to dust can cause irritation to the eyes, skin, and respiratory tract, thus reducing the quality of life and

productivity of workers.(23) In cement material transportation work, there is a potential hazard of exposure to cement dust. This exposure can cause respiratory problems such as respiratory tract irritation, coughing, shortness of breath, and long-term risks such as dust-induced lung disease (pneumoconiosis) if adequate control is not carried out due to the condition of the work area where there are still remnants of cement material attached to the machine. In research conducted by Desianna and Yushananta, (2020), which states that "Although dust exposure is still below the NAB, if exposure occurs continuously for a long time, it will cause respiratory diseases, namely asbestosis, silicosis, pneumocosis."(24) This is also in line with research conducted by Kasman et al, (2024), stating that "Exposure to dust originating from cement loading material where dust is a hazard that can cause respiratory problems that can reduce worker comfort and can experience visual disturbances. exposure to cement dust can also make workers' skin itchy or irritated due to cement material."(25) So the controls that can be carried out are controls that can be carried out, among others, the company regulates working hours, dust collectors in the workspace, periodic health checks, and the use of PPE.

Furthermore, the potential hazard with the highest priority is exposure to chemicals. Exposure to chemicals caused by various chemical liquids, one of which is lubricating fluid, can result in the risk of irritation, burns, poisoning. Bearing lubrication work is at risk of chemical exposure if the lubricant is spilled or in direct contact with the skin, especially with the condition of using lubricants containing irritants and carried out without using personal protective equipment (PPE) such as chemical gloves. This risk can cause skin irritation, allergic reactions, or other health problems if repeated exposure occurs. In a study conducted by Renawati, et al, (2024), which states that "Skin that is frequently exposed to toxic substances can experience a number of health problems such as itching, irritation, rashes, and burns."(26) This is in line with research conducted by Maylasari and Nuravida, (2023), stating that "potential chemical hazards originating from risky oil fluids can result in skin irritation (dermatitis) Contact dermatitis arises due to an inflammatory reaction of the skin exposed to materials that are in direct contact with the skin."(27) so that control efforts can be made Using special or chemical resistant gloves, using face shields, safety shoes, and cleaning the body cleanly to prevent excessive contamination.

Furthermore, the potential hazard with the highest priority is tools that break and hit the worker's body. tools that break and hit the worker's body can cause various types of injuries, ranging from cuts, bruises, to fractures, as well as more serious risks such as injuries to the eyes, head, or internal organs. When lifting segment rollers using a hoist crane, there is a potential hazard in the form of broken tools or lifting aids, which can hit the worker's body. This can occur due to the unfit condition of the equipment, such as worn sling ropes, cracked crane hooks, or lifting capacity that exceeds safe limits. This can result in serious injuries such as broken bones, severe bruising, or even fatality. This can be caused by several factors, such as the use of worn or cracked equipment, excessive pressure or load during use, errors in work procedures, and lack of regular inspection and maintenance of equipment. In a study conducted by Daulay and Nuruddin, (2022), which stated that "The work accident occurred because there was no cover on the grinder so that it could hit the hand and there was a worn grinding eye that caused the grinding eye to break and bounce off the worker's hand." Meanwhile, when viewed from the human side, the cause of the accident was the absence of a cover on the grinder. Meanwhile, when viewed from the human side, the cause of work accidents occurs because of the inattention of workers and workers who do not use PPE.."(28) This is in line with research conducted by Wagiman and Yuamita, (2022), stating that "When cutting iron using a grinding tool, there is a risk of breaking the grinding eye which can cause debris to be thrown at high speed. This has the potential to cause serious injuries such as cuts to the face, eyes, or other parts of the body, especially if workers do not use appropriate personal protective equipment (PPE) such as face shields and safety glasses."(29) Therefore, controls that can be carried out include routine inspection of work tools to detect damage before use. Routinely replace work tools that are no longer

safe to use while working. Using tool protectors such as casings or shields to prevent debris from being thrown, placing workers at a safe distance when using tools that are at risk of breaking.

Conclusion

Based on the results of identifying potential hazards using the *Job Safety Analysis* (JSA) method carried out at the PT XYZ Rawmill Unit, it can be concluded that there are 4 steps that must be taken to identify potential hazards, namely determining the type of work and stages of work, identifying hazards *(Hazard Identification*), risk assessment *(Risk Assessment)*, and risk control *(Risk Control)*. From the results of hazard identification carried out based on hazard factors, there are hazards such as physical hazards, chemical hazards, biological hazards, ergonomic hazards, and psychological hazards and there are 31 sources of danger. Some of the sources of danger found in the PT XYZ Rawmill Unit are mistakes in choosing PPE, PPE that is damaged or not suitable for use, tripping, being pinched, being hit, being electrocuted, being hit, being exposed to welding flares, being exposed to high-pressure gas explosions, being exposed to dust, being scratched, being exposed to chemicals, tools breaking and hitting the body.

From the results of the risk assessment that refers to AS/NZS 4360: 2004 to determine the *Risk Level*, there are 18 potential *High Level* risks with a percentage of 58%, 7 potential *Medium Level* risks with a percentage of 23%, and 6 potential *Low Level* risks with a percentage of 19%. Control efforts that can be made are based on the hierarchy of control controls, namely replacing electrical equipment that is damaged or does not meet standards in order to minimize the occurrence of work accidents and replacing high-voltage electrical equipment with low- voltage electrical equipment *(Subsitution)*. Using protective equipment such as casings or shields to prevent debris from being thrown, placing workers at a safe distance when using tools that are at risk of breaking *(Engineering Control)*. Setting working hours, periodic health checks, installing Safety Sign *(Administration Control)*. And finally provide and complete the availability of PPE for workers so as to prevent or eliminate the possibility of accidents *(Personal Protective Equipment)*.

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