journal

INDUSTRIAL SERVICESS

Vol. 8 No. 1, Juni 2022

JOURNAL INDUSTRIAL SERVICESS

Vo. 8, No. 1, June 2022

Published by:
Department of Industrial Engineering
Faculty of Engineering, Universitas Sultan Ageng Tirtayasa
Cilegon, Indonesia

JISS	Vol. 8	No. 1	Page: 1–125	June, 2022	ISSN (Print) : 24610631 ISSN (Online): 24610623

ISSN (Print) : 24610631
ISSN (Online): 24610623
Journal Industrial Servicess (JISS) Vol. 8, No. 1, June 2022

Journal Industrial Servicess

Editors and Reviewers

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Editorial Preface

Assalamualaikum wr wb.

Praise be to Allah SWT, who always gives us all health. The editorial board expresses deep gratitude to the authors who have submitted their articles to the Journal Industrial Services (JISS) in this issue. We want to thank the editorial board and reviewers who have contributed to this edition.

Journal of Industrial Services (JISS) vol. 1 no. 1 consists of 20 articles submitted by authors from 6 universities in 2 countries (Indonesia and Ethiopia). It is an honor for us, who have won the trust of various writers.

The editorial board always strives to improve the quality of JISS. JISS is a journal accredited by Dikti with the rank of Sinta 4. Therefore, the editorial board is trying to improve the JISS rating. One of the efforts made by the editorial board is to add an editorial advisory board from Waseda University, Prof. Shigeru Fujimura. We also increased the number of international reviewers (Dr. Wen Song and Fellek Getu Tadesse) to improve the quality of submitted articles. In addition, we plan to publish articles in English from October 2022.

The next edition of JISS will be published in October 2022. We always welcome constructive criticism and suggestions to improve the quality of JISS.

Wassalamualaikum wr wb,

Editorial Office

Journal Industrial Servicess, vol. 8, no. 1, Juni 2022

Available online at: http://jurnal.untirta.ac.id/index.php/jiss

JOURNAL INDUSTRIAL SERVICESS

Industrial Engineering Advance Research & Application

eISSN 2461-0631

Hazard identification risk assessment and risk control (HIRARC) of safety junior supervisor in a construction company

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ARTICLE INFO

Keywords:
Work accidents
HIRARC
Diagram Pareto
Diagram F*ishbone*

ABSTRACT

Company Y is a construction company in the fabrication business by working on projects with sub-classifications, namely foundation work including transmitters, roofing and waterproofing work, concrete work, and steel work and its installation. The company also produces machines used to process palm oil, such as threshers, screw conveyor belts, and sterilizers. This company found 15 cases of work accidents occurred from 2017-2020. The purpose of this study is to analyze the causes of frequent accidents and analyze potential hazards and assess the risk of hazards in the company so that it can provide recommendations for appropriate control for the company using the hazard identification risk assessment and risk control (HIRARC) method. There are 5 types of accidents that have occurred frequently and 13 potential accident hazards in the company today. Then for the risk level in the risk assessment, there is 1 event with a high-risk rating (in red), 10 events with a medium level risk rating (yellow), and 11 events with a low-risk rating result (in green). The risk of accidents that should be a priority is the risk of gas cylinder leakage accidents. Accident data for 3 years are depicted in a Pareto diagram and analyzed the cause based on a fishbone diagram, using factors 4M+1E, namely humans, machines, methods, raw materials, and the environment.

1. Introduction

Occupational Health and Safety (OHS) is a field of activity aimed at preventing all types of accidents that have to do with the environment and work situation [1], [2]. In general, accidents are caused by human actions that do not meet safety (unsafe human action) and unsafe environmental conditions (unsafe conditions) [3], [4]. Work accidents often occur due to the non-fulfillment of requirements in the implementation of Occupational Safety and Health. Based on Law No. 1 of 1970 about work safety, an occupational accident is an unexpected and undesirable event that can disrupt the regulated process of an activity and can cause losses to both human and property victims [5]. For this reason, it is necessary to conduct an OHS analysis to identify hazards that can result in work accidents. inflicting losses on both human casualties and property. The danger is the source, situation, or action that has the potential to cause harm in the event of injury or disease to humans. Risk is a combination of the possibility of a dangerous event or exposure to the severity of an injury or health disorder caused by such event or exposure [6], [7].

Company Y is a construction implementation company engaged in the fabrication business by working on projects with sub-classifications, namely foundation work including its transmitter, roofing, and waterproofing work, concrete work, and steel work. The company also produces machines to process palm oil, such as threshers, screw conveyor belts, and sterilizers. To maintain and improve Occupational Health and Safety for workers, one of the efforts made is to analyze the risk of accidents that may occur so that the company can control these risks. Potential work accidents can occur in almost every work activity. Work accidents can be caused by machines as well as factors of the negligence of workers [8]. The purpose of this study is to assess risks and carry out risk control of all hazards found and determining the priority of risks identifying hazards that can occur in the work process and determining the factors that are the cause of the occurrence of work accidents in the company.

The methods used in this study are the HIRARC (Hazard Identification, Risk Assessment, Risk Control) method, Pareto diagram, and Fishbone. The HIRARC method is a series of processes to identify hazards that can occur in routine and non-routine activities in the company, then conduct a risk assessment of these hazards and create a hazard control program so that the risk level can be minimized to a lower one with the aim of preventing accidents [9], [10]. Pareto diagrams are usually created to define and display high-risk processing steps and corresponding corrective actions [11], [12], [13]. The Pareto analysis will help to effectively solve the problem. Pareto's analysis can clearly demonstrate the danger of higher risk in the workplace so that the company can solve the hazard with priority according to the analysis shown [14]. The Fishbone diagram (Ishikawa) represents a suggestive presentation model for the correlation between an event (effect) and the various causes that occur. The structure provided by the diagram helps team members think in a very systematic way [15]. Some of the benefits of building a fishbone diagram are those that help determine the root cause of the problem [16], [17]. The Fishbone diagram is also referred to as a cause analysis introduced by Kaoru Ishikawa, a Japanese management master. This diagram is used to find out the root cause of the problem, showing the relationship between the

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Received: 3 April 2022; Revision: 23 June 2022;
Accepted: 27 June 2022; Available online: 5 July 2022
http://dx.doi.org/10.36055/jiss.v8i1.14719

problem and the underlying cause [18]. Fishbone analysis of diagrams can make complex systems organized, and qualitatively analyze the causes of risks.

The benefit of this research is to assist the company in seeing how big the potential is and how severe if the danger of the accident occurs so that hazard control is prioritized again to prevent it. The resulting control program will determine the direction of implementing K3 in the company in the future in preventing and minimizing accidents and occupational diseases later.

2. Material and method

This research includes a combined approach between a qualitative approach and a quantitative approach. A qualitative approach is research that intends to understand the phenomenon of what the subject of the study experiences such as behavior, perception, motivation, action, holistically and by means of description in the form of words and language, in a special context that is natural and by utilizing various natural methods.

The quantitative approach is research based on the philosophy of positivism, used to examine a particular population or sample, data collection using research instruments, and data analysis are numerical or statistical, with the aim of testing the hypothesis applied. The qualitative approach taken in this study was used to find out what factors affect accidents at work, determine the severity of an accident, determine the probability of an accident (likelihood), determine the level of risk in terms of the aspects of likelihood and severity, and determine the priority of risks to be focused on. The quantitative approach in this study was used when calculating the risk rating, calculating the number of accidents that occurred.

The research was conducted on company Y and the data collected were company data, interview data, direct *surveys* for production machines, and data on machines used in the production process. From the results of interviews and surveys obtained the identification of potential hazards that may occur, then analyzed using the HIRARC method as data for companies to prevent and reduce the potential for workplace accidents in the work process, by identifying the source of the danger, then continued with risk assessment and risk control to reduce exposure to hazards contained in each type of work. The analysis continued with the collection of data on work accidents that often occur over the past 3 years. The data is then classified based on the number and type of accidents using a Pareto diagram. After being depicted with a Pareto diagram, it was analyzed using a fishbone diagram to find the cause of the accident.

3. Results and discussion

According to OHSAS 18001:2007, HIRARC is divided into 3 stages, namely hazard identification, risk assessment, and risk control [19]. The stages in the HIRARC method are detailed as follows.

3.1. Hazard identification

Every accident event is identified and classified into 3 groups, namely N (normal), A (abnormal), and E (emergency). Accidents that may occur, but work is carried out daily and is in accordance with the procedure is defined as normal. Abnormal accident is defined as accidents that may occur, but work is not in accordance with the procedure. Lastly, emergency is defined as possible and difficult accidents to be controlled. The company has 7 work process activities used for production activities, namely iron plate cutting stations, welding, bending, turning, drilling, milling, and rolling plates. The conditions for each hazard risk from the results of the observations be seen in Table 1.

3.2. Risk assessment

Risk Assessment is an assessment process to identify potential hazards that may occur. The purpose of risk assessment is to ensure that the risk control of the process, operation, or activity carried out is at an acceptable level [20]. Risk assessment is carried out based on the Australian Standard/New Zealand Standard for Risk Management scale [21]. Risk assessment is used to determine the level of risk in terms of likelihood and severity [22], [23].

Table 1.
Hazard identification

No	Work process	Hazard	Risk	Condition (N/A/E)
1	Cutting iron plate	Gram of a grinder exposed to body parts	Red rash on the skin, bleeding	A
		Gram used grinders exposed to the eye	Reddish eyes, bleeding, operated	A
2	Welding	Gas cylinder leak	Exploded/fire	E
		Exposed to the eyes	Bleeding, reddened eyes, operated	A
		Burnt skin	peeling skin, bleeding	A
3	Bending	Oil leak	slip, sprained, wound	A
4	Turning	Noisy	Hearing disorders	N
		Smell of smoke	Respiratory disorders	N
		Hands pinched machine	Broken, broken, bleeding	A
		Oil leak	Slash	A
		Eyes exposed to fragments	Reddish eyes, bleeding, operated	A
5	Radial drill	Eyes exposed to fragments	Reddish eyes, bleeding, operated	A
		Noisy	Hearing disorders	N
		Broken drill bit hit by the body	Wound, stabbed, blisters	A
		Dust	Impairment of section	N
6	Milling	Hands pinched machine	Broken, broken, bleeding	A
		Splashes from the remaining gram	Irritation, scratch wound	N
		Oil leak	Slip, sprained, wound	A
		Chisel	Scratch wounds, incision wounds, bleeding	A
7	Roll plate	Oil leak	Slip, sprained, wound	A
		Noisy	Hearing disorders	N
		Hands pinched machine	Broken, broken, bleeding	A

Table 2.
Likelihood scale

Level	Possibility level	Frequency
1	Rarely	Once in every 5 years
2	Unlikely	Once in 2-5 years
3	Possible	Once in 1-2 years
4	Likely	Once in 2-10 months
5	Almost Certaint	Once a month

Table 3.
Severity scale

Level	Severity	Information
1	Insignificant	If there is no impact that is very small for humans, the production process, property, or causing physical care at least in 15 minutes
2	Minor	If there is a small wound but enough only cared for by the P3K team and or causes one working day to disappear or less
3	Moderate	If a moderate injury occurs, it needs medical treatment, causing at least two working days to disappear or less
4	Major	If there are severe injuries and require treatment in the hospital and or cause the working day to disappear for more than two days
5	Catastrophic	If the impact that occurs results in permanent or partial disability or even death

The likelihood is used as a range between a risk that rarely occurs to a risk that can occur at any time. The severity scale is used as a category between events that do not cause injury or only small losses that are the most severe if they can cause fatal events or major damage. The relationship between the likelihood and severity scale to obtain a risk rating scale. So, there are 4 levels of each measuring scale, namely levels 1-4. This level will be multiplied between likelihood and severity to get a risk rating scale so that it can determine whether the type of accident is classified as small, moderate, or very severe.

Table 4.
Risk rating scale on AS/NZS Standard 4360-2004

Likelihood	Severity			
	1	2	3	4
1	1	2	3	4
2	2	4	6	8
3	3	6	9	12
4	4	8	12	16

At the risk assessment stage, each accident event is assessed to determine the level of risk based on the aspects of the probability of occurrence (likelihood) and the severity that can be caused (severity).

At the beginning stage, value weighting is carried out based on likelihood and severity, likelihood, and severity values, after which these values will be multiplied to get the risk rating value. If the risk rating is 1-4, it is categorized as insignificant or small severity, while if the risk rating value is 6-9, it is categorized as moderate severity, and if the risk rating value is 12-16, it is categorized as sufficient or very severe severity. The results of the risk assessment can be seen in Table 5. The priority accident risk is the event with the highest level of risk. In this case, is a gas cylinder leakage event at the welding station.

3.3. Risk control

Risk control aims to minimize the level of risk from potential hazards that exist [24]. Repairs are carried out as a follow-up step to the identification of accident risk. At each event, control measures are carried out to prevent or at least reduce the level of risk to a lower level. The control measures for each event can be seen in Table 6.

Table 5.
Risk rating

No	Process	Hazard	Risk	Condition	L	S	RR
1	Cutting iron plate	Gram of a grinder exposed to body parts	Red rash on the skin, bleeding	A	4	1	4
		Gram used grinders exposed to the eye	Reddish eyes, bleeding, operated	A	2	2	4
2	Welding	Gas cylinder leak	Exploded/fire	E	3	4	12
		Exposed to the eyes	bleeding, reddened eyes, operated	A	2	2	4
		Burnt skin	peeling skin, bleeding	A	3	1	3
3	Bending	Oil leak	slip, sprained, wound	A	4	2	8
4	Turning	Noisy	Hearing disorders	N	4	1	4
		Smell of smoke	Respiratory disorders	N	3	1	3
		Hands pinched machine	Broken, broken, bleeding	A	2	3	6
		Oil leak	Slash	A	4	2	8
		Eyes exposed to fragments	Reddish eyes, bleeding, operated	A	2	2	4
5	Radial drill	Eyes exposed to fragments	Reddish eyes, bleeding, operated	A	2	2	4
		Noisy	Hearing disorders	N	4	1	4
		Broken drill bit hit by the body	wound, stabbed, blisters	A	3	1	3
		Dust	Impairment of section	N	3	3	9
6	Milling	Hands pinched machine	Broken, broken, bleeding	A	4	2	8
		Splashes from the remaining gram	Irritation, scratch wound	N	3	2	6
		Oil leak	slip, sprained, wound	A	4	2	8
		Chisel	scratch wounds, incision wounds, bleeding	A	3	2	6
7	Roll plate	Oil leak	slip, sprained, wound	A	4	2	8
		Noisy	Hearing disorders	N	4	1	4
		Hands pinched machine	Broken, broken, bleeding	A	2	3	6

Note: L = Likelihood, S = Severity, RR = Risk rating

Table 6.
Risk control

No	Process	Hazard	Risk	Controlling
1	Cutting iron plate	Gram of a grinder exposed to body parts	Red rash on the skin, bleeding	Using a complete PPE according to working conditions, removing the used gram in its place
		Gram used grinders exposed to the eye	Reddish eyes, bleeding, operated	Using a complete PPE according to working conditions, removing the used gram in its place
2	Welding	Gas cylinder leak	Exploded/fire	Check and maintenance in stages, providing APAR near the gas cylinder
		Exposed to the eyes	bleeding, reddened eyes, operated	Use complete PPE according to working conditions
		Burnt skin	Peeling skin, bleeding	Use complete PPE according to working conditions and always pay attention to the use of welding machines
3	Bending	oil leak	Slip, sprained, wound	Cleaning the location regularly, always using safety shoes when passing through that location
4	Turning	Noisy	Hearing disorders	Using earmuffs when doing work that can cause noise
		Smell of smoke	Respiratory disorders	Use masks during production activities
		Hands pinched machine	Broken, broken, bleeding	Using complete PPE according to working conditions, checking and maintenance of machines regularly
		Oil leak	Slash	Cleaning the location regularly, always using safety shoes when passing through that location
		Eyes exposed to fragments	Reddish eyes, bleeding, operated	Using a complete PPE according to working conditions, removing the used gram in its place
5	Radial drill	Eyes exposed to fragments	Reddish eyes, bleeding, operated	Using a complete PPE according to working conditions, removing the used gram in its place
		Noisy	Hearing disorders	Using earmuffs when doing work that can cause noise
		Broken drill bit hit by the body	Wound, stabbed, blisters	Using complete PPE according to working conditions, checking and maintenance of machines regularly
		Dust	Impairment of section	Use masks during production activities
6	Milling	Hands pinched machine	Broken, broken, bleeding	Using complete PPE according to working conditions, checking and maintenance of machines regularly
		splashes from the remaining gram	Irritation, scratch wound	Using a complete PPE according to working conditions, removing the used gram in its place
		oil leak	Slip, sprained, wound	Cleaning the location regularly, always using safety shoes when passing through that location
		chisel	Scratch wounds, incision wounds, bleeding	Using complete PPE according to working conditions, checking and maintenance of machines regularly
7	Roll plate	oil leak	Slip, sprained, wound	Cleaning the location regularly, always using safety shoes when passing through that location
		Noisy	Hearing disorders	Using earmuffs when doing work that can cause noise
		Hands pinched machine	Broken, broken, bleeding	Using complete PPE according to working conditions, checking and maintenance of machines regularly

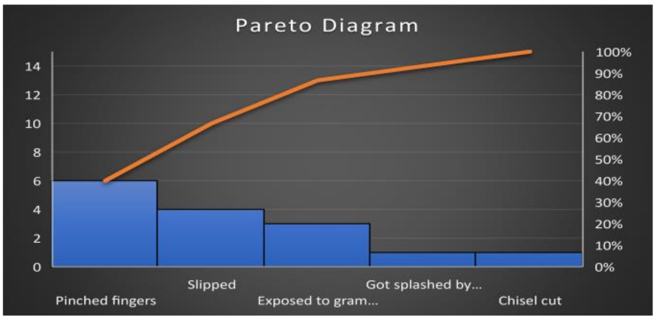

Figure 1. Pareto diagram

In events with red risk rating results, precautions must be taken immediately to eliminate the risks that may occur. In events with yellow risk rating results, it can be accepted if all security has been implemented. In events with green risk rating results, it is not mandatory or not urgent to take control measures because the risk of danger can still be tolerated, but it is recommended to continue to use personal protective equipment (PPE) and follow the standard operating procedure (SOP) completely. In the process of cutting iron plates, there are 2 hazards identified with a green risk rating scale which indicates there are 2 risks of work accidents with small or insignificant severity.

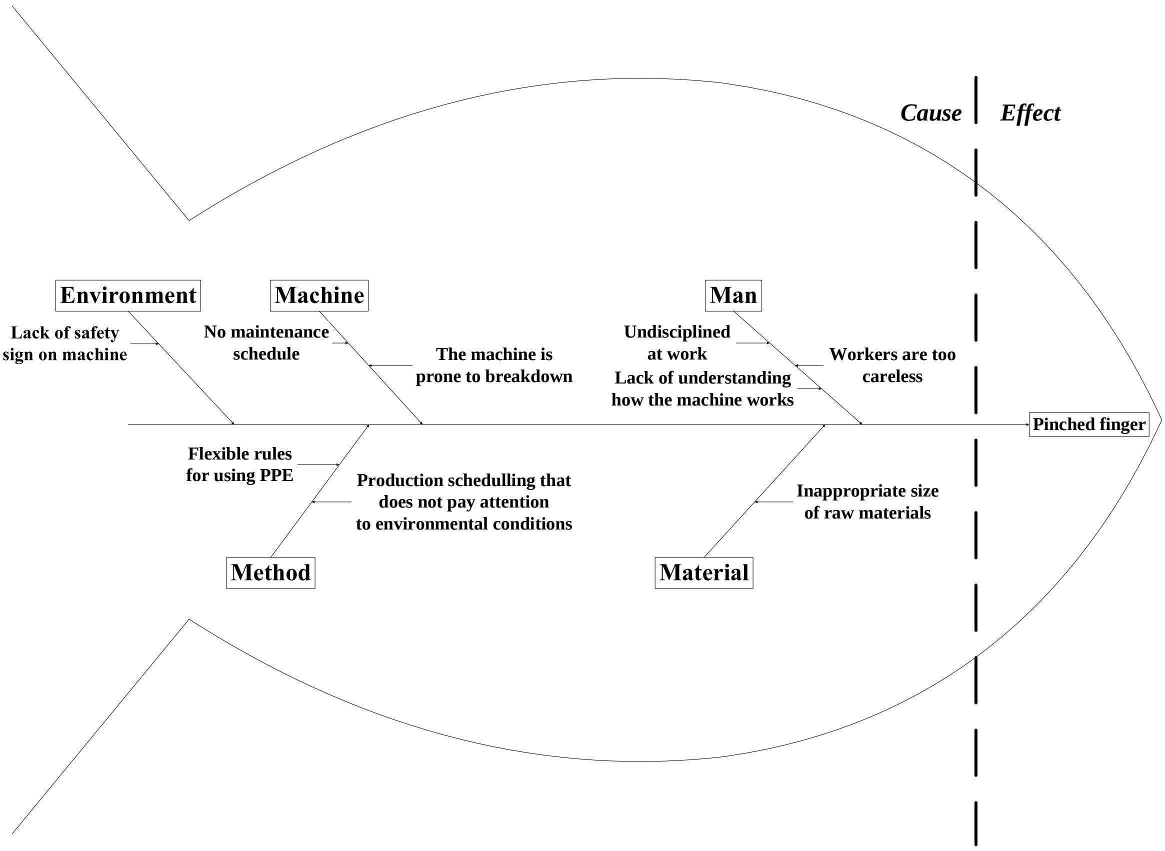

Figure 3. Fishbone diagram on pinched finger accident type

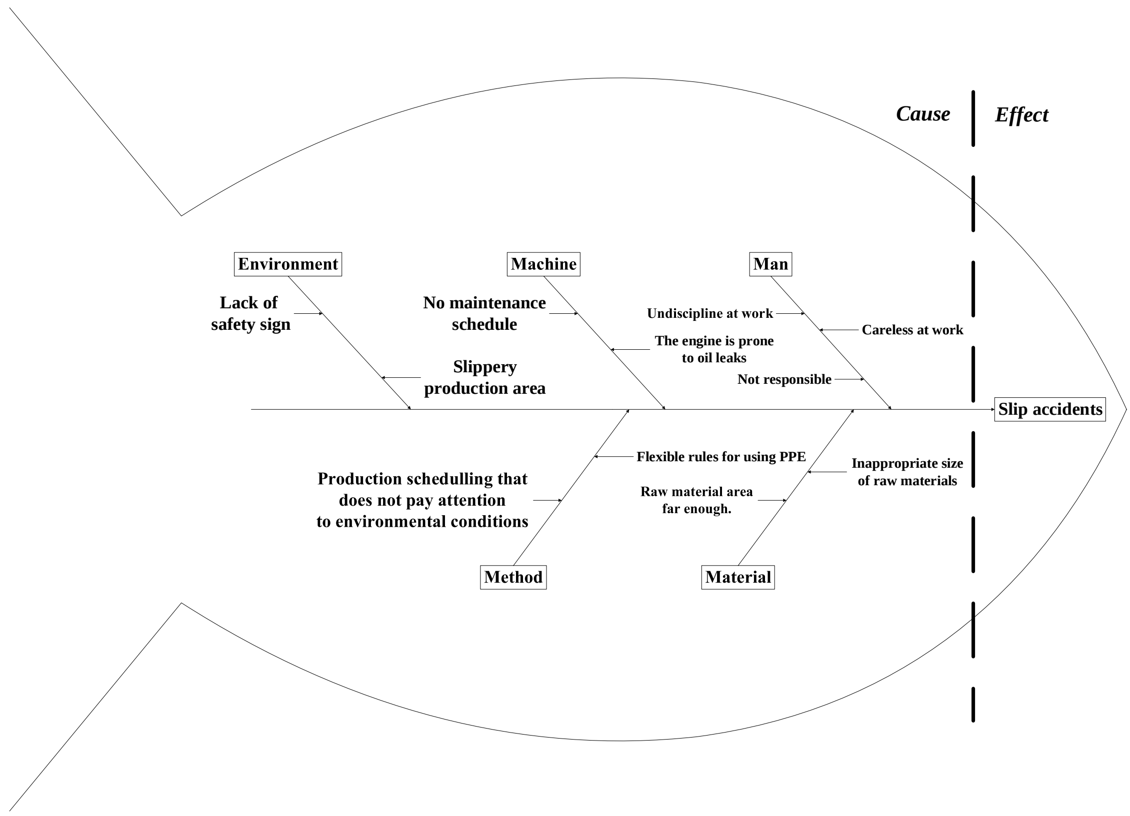

Figure 4. Fishbone diagram on types of slip accidents

In the process of welding activities, there are 3 hazards identified with 2 green risk rating scales and 1 risk scale with a red rating which indicates there are 2 risks of work accidents with small or insignificant severity and 1 risk of work accidents with sufficient severity or very dangerous. In the bending activity process, there is 1 hazard identified with a yellow risk rating scale which indicates there is 1 risk of a work accident with moderate severity. In the process of turning there are 5 hazards identified with 3 green risk rating scales and 2 yellow risk rating scales which indicate there are 3 risks of work accidents with small or insignificant severity and 2 risks of work accidents with moderate severity.

In the process of drilling activities, there are 4 hazards identified with 3 green risk rating scales and 1 yellow risk rating scale which indicates there are 3 risks of work accidents with small or insignificant severity and 1 risk of work accidents with moderate severity. At the milling work station, there are 4 hazards identified with 4 yellow risk rating scales which indicate there are 4 risks of work accidents with moderate severity. In the roll plate activity process, there are 3 hazards identified with 1 green risk rating scale and 2 yellow risk rating scales which indicate there is 1 risk of work accident with small or insignificant severity and 2 occupational accident risk with moderate severity.

The results of risk control on the red risk rating take preventive action by eliminating the dangerous risks that may occur. The yellow risk rating can be accepted if all safeguards have been implemented. While the risk rating is green, it is not necessary to take hazard control measures because the risk of danger can be tolerated but workers are still required to use complete PPE (Personal Protective Equipment).

The number of distributions in the process of activities with a low risk level is 50%, where this percentage is not significantly different from the percentage of distributions with a moderate risk level of 45%. For a high risk level, it has a percentage of 5%, so the company can focus on controlling and minimizing the risk.

3.4. Managerial implications

A pareto diagram is a diagram that describes the number and type of accidents that occurred during a given time. The accidents that have occurred so far are the kind of accidents of pinched fingers, slipping, being hit by iron grams, being hit by splashes of fire, and being slashed by a chisel. The highest risk of accidents is the accident of a pinched finger and an operator slipping as shown in Figure 1.

The fishbone diagram was analyzed based on the results of the Pareto diagram on both types of accidents with the highest frequency, namely pinched fingers and slipping operators. It was found that there were several factors that were the cause of accidents at work.

The following is the result of an 4M+E analysis for pinched fingers.

a. Man: Workers who are too careless when using the machine can experience pinched fingers. Workers also like to be unfocused at work. Some workers who do not fully understand the use of production machines cause the risk of this accident to occur is getting higher and higher. Workers who lack discipline at work, such as: chatting often, often forgetting to use safety equipment, etc.
b. Method: Production scheduling does not pay attention to the condition of the machine where the machine continues to work even though it has suffered damage to spare parts or it is time for maintenance. This can cause fatal damage to the engine which can lead to the risk of work accidents, such as explosions, fires, oil leaks, etc. The rules for the use of PPE are too flexible where workers are not sanctioned when they do not use full PPE. This can create the risk of unwanted work accidents occurring and can lead to fatal work accidents.
c. Material: The size of the raw material is not suitable so that it can cause damage to the machine, for example, the engine cover is given an inappropriate bolt so that it makes the machine cover loose and closed which makes the worker's finger pinched.
d. Machine: There is no scheduling on the production machines which make the machines prone to damage. This can make the engine experience errors or can have an impact on workers such as oil engines that leak easily, *engines overheat,* etc. Of course, this can result in work accidents. Machines tend to experience damage such as machine door covers that like to close themselves which can pinch workers' fingers.
e. Environment: Lack *of safety signs* in places that are likely to occur in work accidents. This can make people in the production area is not careful. Currently, the company only has *signs* showing the names of the machines. So that for areas that can cause the risk of accidents, there is no *safety sign*. *Safety signs* are important for workers, especially for workers who are new and don't know anything.

Slippery and rarely cleaned production areas can cause workers to slip. The following is the result of an 4M+E analysis for slip accidents.

a. Man: Less responsible workers when using the machine. When using the engine and then there is an oil leak that can cause the floor to be slippery, there are workers who are silent and do not report it. This makes other workers know nothing that can make a slip. Workers who lack discipline at work, such as: often chatting, often forgetting *to use safety equipment*, etc.
b. Method: Production scheduling does not pay attention to the condition of the machine where the machine continues to work even though it has suffered damage to *spare parts,* or it is time for *maintenance*. This can cause fatal damage to the engine which can lead to the risk of work accidents, such as explosions, fires, oil leaks, etc. The rules for the use of PPE are too flexible where workers are not sanctioned when they do not use full PPE. This can create the risk of unwanted work accidents occurring and can lead to fatal work accidents.
c. Material: The taking of raw materials is quite far because there is a special placement of raw materials where the workers have to take their own. This makes workers often go back and forth whose risk of experiencing this type of work accident slips higher.
d. Machine: The engine door often closes itself because the bolts on the engine are loose. As a result, the operator is often squeezed by the door of the machine. Scheduling on production machines is also not good so many engines experience *errors* or *overheating or* experience oil leaks. Engines tend to experience damage such as oil leaks that can make workers slip. This happens quite often in the production area.
e. Environment: Lack *of safety signs* in places that are likely to occur in work accidents. This can make people in the production area not careful. At this time, the company only has *signs* showing the names of machines and some warnings about machine use, but many *of the safety signs* owned by the company are unclear and cannot be read. For some areas that can cause accident risk, there is also no *safety sign*. In fact, often workers smoke in production areas where there are several gas cylinders for production activities.

4. Conclusion

Based on the HIRARC method, 11 events were obtained with green risk rating results, 10 events with yellow risk ratings, and 1 event with a red risk rating. The risk of accidents that should be a priority is the risk of gas cylinder leakage accidents. The most frequent type of accident in company Y is the type of pinched and slipped finger accident. The cause of accidents occurring based on fishbone diagrams is due to workers who are often careless, undisciplined, do not wear complete PPE, machines that often experience errors or damage, raw materials whose size does not match the machine, suboptimal machine scheduling, slippery production areas and rarely cleaned, and the absence of safety signs installed in the production floor area.

Proposed improvements that must be implemented are the use of complete PPE for workers, clear and strict sanctions for undisciplined workers, routine and regular machine maintenance schedules, regular cleaning of production areas, and adding safety signs in production areas, especially in crucial locations.

Acknowledgement

Penulis mengucapkan terima kasih sebesar-besarnya kepada para penelaah yang telah memberikan banyak masukan untuk kesempurnaan artikel ini.

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ISSN (Print) : 24610631
ISSN (Online) : 24610623

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