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Identification Of Potential Hazards In Palm Oil Companies In The Sterilizer Section Using The HIRARC Method

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ABSTRACT

Worker safety is a critical factor in the continuity of an oil palm industry because the progress of the palm oil industry is also influenced by the availability of safety guarantees for its workers. Based on the results of the study, it was shown that the highest percentage of accident risk assessment was at the sterilizer work station (boiling FFB) using the HIRARC method, namely in the activity of pulling the cable sling from the winch and then attaching the hook to the lorry from the transfer carriage with 25 the risk of accidents occurring with a percentage of 33.33 % and categorized into extreme, for the second highest accident risk assessment, namely in the activity of pulling a lorry using a winch and in the activity of opening the sterilizer door and lowering the sterilizer bridge with a work accident risk of 16 times with a percentage rate of 21.33% and categorized into high incident and the risk of work accidents, namely in the activity of releasing the hook and carrying it then installing it to the last lorry and in the activity of pulling and carrying sling cables from the winch with a risk of accidents of 9 times the incidence of work accidents with a percentage rate of 12.00% and categorized into incident medium.

Keywords: *Minimizing the Risk of Occupational Accidents and the HIRARC Method.*

Introduction

Advances in digital technology are currently needed to facilitate work to meet community needs, but without proper supervision, it is detrimental to the community itself[1], [2]. The use of advanced technology is unavoidable, especially in industrial needs, which are characterized by processes of mechanization, electrification, and modernization, as well as in the transformation of globalization, which uses machines, equipment, and hazardous materials, which continue to increase industrial needs [3]–[5].

Occupational accidents are events that often occur compared to other accidents; the impact is immediately felt and seen, and the incident is recorded and reported in company documents [1], [6], [7]. In addition, work accidents are also events that harm people and cause damage to property or processes. These accidents are usually also caused by contact with a substance or energy source [2], [8]–[10].

There are still several obstacles to preventing work accidents, one of which is the existence of a traditional way of thinking that views accidents as disasters when people are separated[11]–[13]. One way to prevent accidents from happening is to use the HIRARC (Hazard Identification, Risk Assessment and Risk Control) method. The method is a series of K3 applications, starting with good planning, including hazard identification, risk assessment, and fixed control measures based on data collected to provide a comprehensive HIRARC study power model [14]–[16].

PT. X is a company engaged in the plantation sector and processing palm oil. Crude Palm Oil (CPO) and kernels are the main products—implementation of work safety programs and their relationship with efforts to increase work productivity where PT. X is already committed to preventing and reducing work accidents and occupational diseases. However, in reality, work accidents still occur, and workers are still classified as not meeting safety and security standards because it is found that most workers do not use APD provided by the company, such as gloves, safety helmets, and safety glasses. Based on accident case data for five years, as shown in Table 1. below:

Table 1. Number of Work Accidents at PT. X Year 2018-2022

Year	Month (people)												Total
	Jan	Feb	Mar	Apr	Mei	Jun	Jul	Aug	Sep	Oct	Nov	Des	
2018	8	0	2	5	0	2	2	0	0	2	0	1	**22**
2019	0	1	1	0	4	3	0	5	2	1	2	0	**19**
2020	1	3	0	1	1	2	0	1	2	0	1	4	**16**
2021	0	0	5	1	2	0	0	0	1	0	2	0	**11**
2022	5	0	2	3	0	0	0	0	0	0	0	0	**10**

(Source: PT. X, 2022)

Based on the survey results of PT. X, in a period of five years (2018-2022), experienced fluctuations (up and down) in accident data at PT. X in 2018, there were work accidents of 22 people. Thirteen workers had accidents caused by being exposed to quite hot steam at the sterilizer station. Sharp objects cut seven people during the boiling machine repair process, while two other workers had accidents due to being pinched by the sterilizer machine while repairing it. The high number of accidents in 2018 was due to the carelessness of workers who underestimated the use of personal protective equipment. In 2019, a work accident at PT. X decreased by 19 people, and eleven workers suffered serious burns due to exposure to hot steam at the sterilizer station. Four workers had an accident caused by being squeezed during machine repair at the sterilizer station, while four more workers were due to slipping. The decrease in the number of work accidents is because the company is committed to implementing a K3 program that is in accordance with the standards set by the government to produce zero accidents so that work time is not wasted, which causes losses for the company. In 2020, the number of accidents has decreased again; namely, as many as 16 workers experienced work accidents caused by eight workers being exposed to hot steam pressure during the TBS boiling process, five workers slipped, while three other workers experienced work accidents caused by being pinned sterilizer machine when repairing the machine, the decrease in the number of work accidents is due to the company's consistency in implementing this K3 program. Whereas in 2021, the number of work accidents has decreased again, namely by 11 workers, nine workers have had accidents due to burns caused by boiling steam, and two people have had work accidents caused by slipping. The decrease in the number of work accidents this year is due to K3 management at PT. X held a K3 program training. In 2022, the number of work accidents has decreased again, namely ten workers, three people had accidents caused by slipping, five people were exposed to steam pressure when boiling FFB, and the other two workers had accidents caused by slipping.

Seeing the problems above, it is necessary to prevent the dangers of work accidents in the workplace to minimize and reduce the number of work accidents and prevent work accidents. It is essential to analyze the risk of accidents that occur by carrying out risk identification to determine existing sources of danger and risk assessment to determine the potential and level of risk in each workplace, one of which uses the HIRARC (Hazard Identification, Risk Assessment, and Risk Control) method [17]–[19].

The HIRARC method is a method that is useful for any dangerous activity so that it can directly detect and control it immediately so that the potential for work accidents can be minimized. The HIRARC method can set directions in dealing with accident cases that occur in companies so that companies will be able to solve their problems later—especially management issues within the company [20]–[22].

Research Methods

Based on its nature, this research is classified as descriptive research, namely research that systematically and effectively solves an existing problem based on factual information about existing symptoms and seeks real information to find out the truth in data by identifying and evaluating sources of danger. Posed by risks in each work area [2]. Place and Time of Research Implementation

This research was conducted at PT X, which is located in Tadu Raya District, Nagan Raya Regency. The company is engaged in the plantation and refining of palm oil, whose main products are crude palm oil (CPO) and kernels. The location is as shown in Figure 1 below:

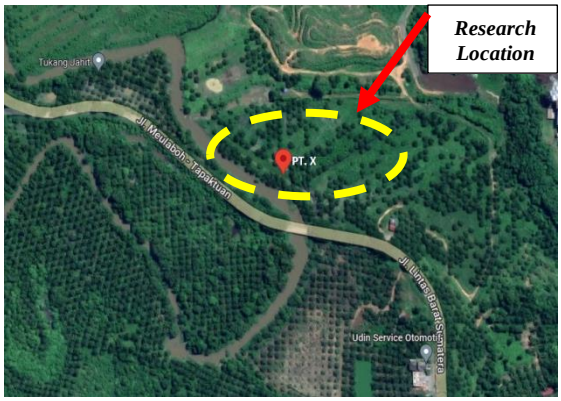

Figure 1. Research Location

Research design

The research plan can be seen in the research methodology flowchart in Figure 2. as follows:

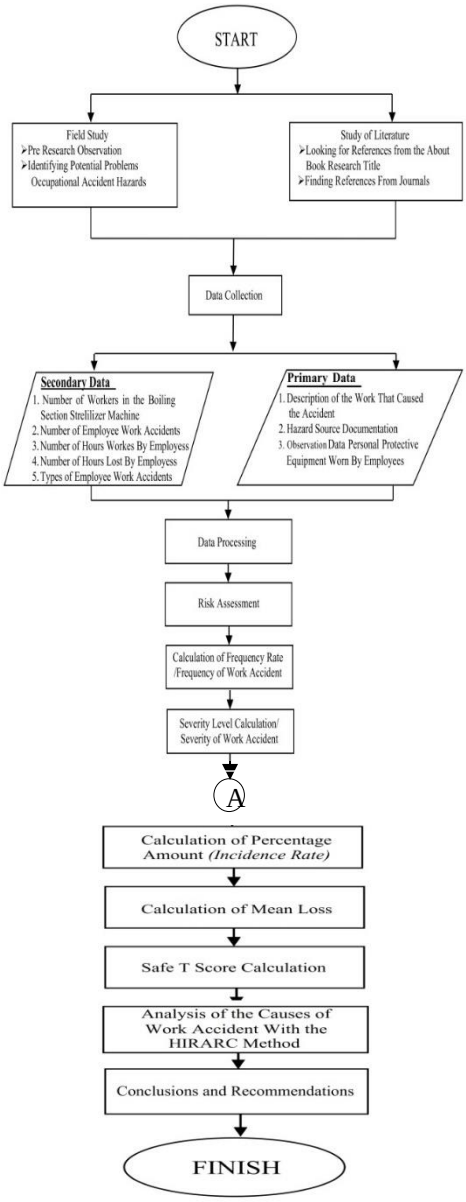

Figure 2. Research Flowchart

Based on Figure 2 of the research flowchart above, the research procedure is as follows:

Introduction

Prepare research by identifying problems that often occur in companies, submitting ideas and ideas in conducting final project research to industrial and corporate engineering departments, and discussing with the final project coordinator and supervisor when working on a proposal.

Study of literature

A literature search in order to study the theory that will be used in accordance with the research title on occupational accidents and health using the HIRARC method.

Data Collection

In research, the methods used to collect data include:

1. Observation Techniques
   This is done directly at the factory, especially in the boiling section of fresh fruit bunches (TBS), to find out all the information needed to solve problems.
2. Interview technique
   This method is by interviewing directly with the manager or worker about problems related to the data needed to achieve research objectives.
3. Library Engineering
   This method is by looking for references in accordance with the research objectives.

The data obtained in this study consisted of primary and secondary data, namely:

1. Primary data is data collected by direct observation where the data includes:
   a. Work activities that lead to accidents
   b. Hazard occurrence documentation
   c. APD observation data used by employees
2. Secondary Data is data that already exists within the company where the secondary data used includes the following:
   a. Total Production Workforce
   b. Total work accidents
   c. Total working hours
   d. Total hours lost due to accidents
   e. , Types of work accidents

Data Processing

1. Calculation of Risk Assessment
   Data processing is carried out by calculating the risk rating, which is done after the three elements of risk, namely consequences, exposure, and probability, to produce a breadth in proving the level of risk by multiplying the three aspects with the formula:

Risk = Consequences x Exposure x Probability... (1)

Based on the results of calculating the risk level using the formula above, it is then grouped according to the descriptive risk level shown in Table 2 below:

***Table 2**. Semi-quantitative risk level analysis* [23]–[25]

Range	Kategori	Tindakan
> 350	Very high	Operations are suspended until the risk can be reduced to an acceptable or tolerable level.
180 - 350	Priority 1	Need to check regularly
70 - 180	High	need for technical improvements
20 - 70	Priority 3	Must continue to monitor periodically
< 20	Acceptable	Seriousness in dealing with the impact of work accidents so that they can be minimized as much as possible

$$Risk\ Reduction\ = \frac{Basic\ Level\ \times\ Exissiting\ Level}{Basic\ Level} \quad (1)$$

Once the risk level is determined from a semi-quantitative analysis, a risk mitigation score is determined, with risk mitigation included in each work area, taking into account existing organizational controls. Risk reduction is determined by subtracting the underlying risk from the existing risk using the following formula:

Furthermore, the activities in assessing the identification of potential accidents when working are references used in assessing the occurrence of a risk, as shown in Table 3. The following:

Table 3. Likelihood standard AS/NZS 43606

Skala HIRARC	Keterangan	Keterangan
5	*Catastrophic*	Death ≥ 1 person, the damage is very large, and the effects are very extensive, cessation of all operations.
4	*Major*	Serious injury ≥ 1 person, serious damage, production stoppage
3	*Moderate*	The injury is severe enough to require medical treatment and significant cost loss.
2	*Minor*	Small injury, small cost loss
1	*Insignificant*	No injuries, minor cost damage

Table 4. Risk Matrix Scale AS/NZS 43605

Risk Frequency	Risk Impact				
	1	**2**	**3**	**4**	**5**
5	H	H	E	E	E
4	M	H	E	E	E
3	L	M	H	E	E
2	L		M	H	E
1	L	L	M	H	H

Table 5. Scale likelihood standard AS/NZS 43603

Skala Penilaian HIRARC	Keterangan	Keterangan
5	Almost sure happened	Occurrence of ≥ 1 work accident in every 8 hours of work
4	Might happen	Occurrence of ≥ 1 work accident in every 24 hours of work
3	Could occur	Occurrence of ≥ 1 work accident in 7 working days
2	Not Occur	Occurrence of ≥ 1 work accident in 30 working days
1	Rare happens	Occurrence of ≥ 1 work accident in 1 year of work

2. Calculation of the frequency of work accidents.
The calculation of the frequency rating is to show the number of accidents per million hours worked. This can be done by calculating the frequency (FR), which is the number of accidents per million hours worked, while the equation used is in accordance with the following formula:

$$FR = \frac{\text{Number of Accidents (n)} \times 1.000.000}{Number\ of\ working\ hours\ (N)} \quad (2)$$

Where :
FR = Frequency of accidents
n = Total accident
N = Total working hours

3. Calculation of Severity of Accident Severity
The calculation of the severity of an accident is a measure of the occurrence of an accident, with the severity of an accident being calculated as the number of hours worked per million hours worked. The formula used is:

$$S = \frac{Hx1.000.000}{N} \quad (3)$$

Where:
S = The level of severity/severity of the accident
H = Total lost hours of work
N = Total working hours

4. Accident Percentage Calculation (Incident Rate)

The calculation of the percentage of accidents (incidence rate) is where the percentage of the number of accidents is used to explain the percentage of total work accidents. The formula used is as follows:

$$\text{IL} = \frac{\text{Number of Work Accidents (n)} \times 100}{Number\ of\ Workers\ (N)} \quad (4)$$

Where:
IL = Percentage of Number of Accidents
n = Number of Workers (N)

5. Calculation of the average loss of working days (Average Time Losst Rate/ALTR)

The calculation of the average loss of working days, which is an indicator of the 'Duration Rate,' is used to identify the severity of work accidents. The average lost workdays formula is used as follows:

$$\text{ALTR} = \frac{\text{Total Lost Days}}{\text{Number of Accidents}} \quad (5)$$

Where:
ALTR = Average Lost Workdays
n = Number of Work Accidents

6. Calculation of Safe T Score/Safe T Value

The calculation of the safe T Score or safe T Value is a comparison of the results of past accident rates to future events. This is intended to determine the level of reducing accident rates. Happy T-values are used according to reference to accident control tests in statistics. The formula used is:

$$Familly\ Safe\ \text{T}\ Score\ (\text{Sts}) = \frac{\text{F2} - \text{F1}}{\sqrt{\frac{\text{F1}}{N}}} \quad (6)$$

where: Sts = T Value safe
F1 = The frequency with which accidents occurred in the past
F2 = The frequency with which accidents occurred in the future
N = Total working hours

7. Analysis

After processing the data obtained, it is then analyzed and evaluated against the frequency of accidents, the severity of the accidents, and the safe t value. It analyzes the main factors that lead to accidents so that the results of the causes can be evaluated according to the HIRARC method in order to minimize the occurrence of work accidents.

8. Conclusions and Suggestions

At the end of the research, the next step is to conclude according to the research objectives. Then, the authors make constructive suggestions in decision-making for improvement for the company and subsequent research.

Results and Discussion

Data collection

1. Data on Total Work Accidents

The total work accidents that occurred at X in 2018-2022 are shown in Table 6. as follows:

Table 6. Data on Total Work Accidents

Year	Month (people)												Total
	Jan	Feb	Mar	Apr	Mei	Jun	Jul	Aug	Sep	Oct	Nov	Des	
2018	8	0	2	5	0	2	2	0	0	2	0	1	**22**

2019	0	1	1	0	4	3	0	5	2	1	2	0	**19**
2020	1	3	0	1	1	2	0	1	2	0	1	4	**16**
2021	0	0	5	1	2	0	0	0	1	0	2	0	**11**
2022	5	0	2	3	0	0	0	0	0	0	0	0	**10**

2. Data on Total Workforce and Total Working Hours/Month/Year

Based on the total workforce in PT. X, the total working hours and total working hours/year in 2018-2022 are obtained in Table 7. as follows:

Table 7. Data on Total Workforce and Total Working Hours/Month/Year

Tahun	Tenaga Kerja (Orang)	Jumlah Jam Kerja/Bulan (Jam Orang)	Total Jumlah Jam Kerja Tahun (Jam Orang)
2018	18	4.320	51.840
2019	17	4.080	48.960
2020	15	3.600	43.200
2021	15	3.600	43.200
2022	15	3.600	43.200

Source: PT. Beurata Subur, 2022)

Where :
• The average working day per month is 30 days
• Total working hours in 1 working day is 8 hours

3. Data on the Recapitulation of the Number of Employees' Missing Hours

The results of the work accident data above yield a recapitulation of the total lost working hours in 2018-2022 in Table 8 below:

Table 8. Total Worker Hours Lost

Year	Number of accidents (people)	Lost Days (Days)	Lost Hours (Hours)
2018	22	50	400
2019	19	35	280
2020	16	28	224
2021	11	22	176
2022	10	20	160

(Source: PT. X, 2022)

Where: Total working hours in 1 day is 8 hours

Data processing

1. Hazard Identification with the HIRARC Method

Identification of hazards with the HIRARC method, which identifies accidents (hazard identification), assesses risks (risk assessment), and
controls risks (risk control). The potential for accident reduction is used as a reference value in controlling work accidents. Accident identification activities at PT. X can be described according to Table 9. below:

Table 9. Identification of Accidents in the Sterilizer Work Area

No	Boiling Section FFB (Sterilizer Machine)	Accident Identification	Accident Form
1	Lorry withdrawal using a winch	Broken hook hook	The operator slipped and hit his head on the lorry
2	Pull the sterilizer door and lower it onto the sterilizer bridge	Hot steam from steam engine Strelilizer	When pulling open the sterilizer door, the operator is at risk of steam pressure in the hot steam of the sterilizer.
3	Release the hook, then attach it to	Slippery boiling areas	Slipped, and the head of the operator

	the last lorry	and broken winch cables	hit the lorry, and the operator's hand could be stuck in the sling cable fibers.
4	Pulling the cable sling on the winch, then attaching the hook to the lorry on the transfer carriage	Cable slings on a Disconnected Winch	Operators can slipped, pinched and the head of the operator was hit by a Lorry
5	Pulling and carrying cable slings on the winch	Cable slings on a Disconnected Winch	Operators can Slipped, pinched, and could be punctured by sling cable fibers.

Based on Table 9 above, the next step is to identify the severity of accidents in the work area where accidents can be caused by several factors, including physical, machine, chemical, mechanical, electrical, ergonomics, habits, environmental, biological and psychological accidents according to the assessment reference according to Table 3-4 before. The results of the accident severity identification are shown in Table 10 below:

Table 10. Identification of accident severity

No	Boiling Section TBS (Sterilizer Machine)	Because of an accident	Crash Effect	Accident Severity Category
1	Lorry withdrawal using a winch	Broken hook hook	The operator slipped and hit his head on the lorry	*Major*
2	Open the sterilizer door and lower the sterilizer bridge	Hot steam from steam engine Strelilizer	When pulling open the sterilizer door, the operator runs the risk of being exposed to steam pressure from inside the sterilizer.	*Major*
3	Release the hook and carry, then attach it to the last lorry	Slippery boiling areas and broken winch cables	Slipping and the head of the operator can be stamped on the lorry, and the operator's hand can be pricked in sling cable fibers.	*Moderate*
4	Pulled the winch sling cable, then hooked it to the lorry on the transfer carriage	Broken cable sling on the winch	Operators can Slipped, pinched and the head of the operator fell lorry operators can	*Catastrophic*
5	Pulling and carrying cable slings on the winch	A broken cable sling on a winch	Slipped, pinched, and could be punctured by sling cable fibers.	*Moderate*

After identifying the level of severity, the next step is a risk assessment (risk assessment), where the assessment is made in the form of a risk assessment table. Risk assessment is an evaluation process for identifying accidents. The reference scale used in the risk assessment is according to Tables 3 and 4 previously. The risk assessment is in accordance. Table 11 is as follows:

Table 11. Risk Assessment

No	Part boiling TBS (Sterilizer Machine)	Crash Effect	Skor		*Risk*	*Risk Level*
			Likelihood	*Severity*		
1	Lorry withdrawal using a winch	The operator slipped and hit his head on the lorry	4	4	16	*High*
2	Pull the door of the sterilizer and lower it to the bridge of the sterilizer	Interesting moment door sterilizer, the operator is at risk of steam pressure on hot steam sterilizer	4	4	16	*High*
3	Removing the hook, then	The operator	3	3	9	*Medium*

	attaching it to the last lorry. It slipped, and the operator's head hit the lorry, and the operator's hand could get stuck in the sling cable fibers.	slipped and hit the lorry, and the operator's hand could get stuck by a sling cable fiber.				
4	Pulling the cable sling on the winch, then attaching the hook to the lorry on the transfer carriage	Operators can slip, squeezed and the chief operator is hit by a lorry	5	5	25	*Extreme*
5	Pulling and carrying cable slings on the winch	Operators can Slipped, pinched, and could be punctured by sling cable fibers	3	3	9	*Medium*

Based on Table 11 of the risk assessment above, the risk assessment is obtained by multiplying the likelihood and severity columns so that the results of calculating the percentage of risk assessment are accepted, as shown in Table 11. below:

Table 12. Percentage of Risk Assessment

Boiling Section	***Risk Rating***	**Risk Value**	**Percentage (%)**
TBS (Sterilizer Machine)	*High*	16	21,33
Pulling the lorry using the winch	*High*	16	21,33
Pull the sterilizer door and lower it onto the sterilizer bridge	*Medium*	9	12,00
Release the hook, then attach it to the last lorry	*Extreme*	25	33,33
Pulling the cable sling on the winch, then attaching the hook to the lorry on the transfer carriage	*Medium*	9	12,00
Total		**75**	**100**

The results from Table 11 above explain that the highest percentage of accident risk is in the activity of pulling the sling cable on the winch, then attaching the hook to the lorry on the transfer carriage with a percentage of 33.33%, while the lowest rate is in the activity of releasing the hook, then attaching it to the most recent lorry and pulling and carrying sling cables from the winch with a percentage of 12.00%, so that it is clear as shown in Figure 1. below:

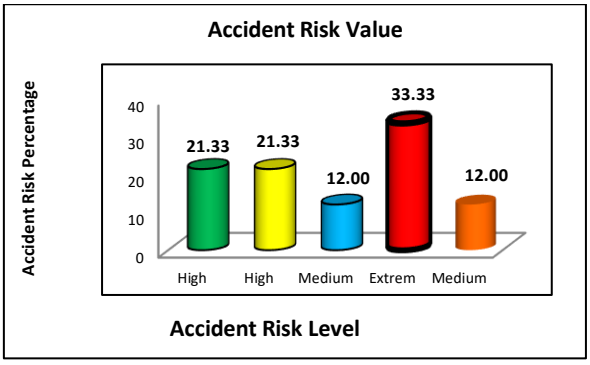

Figure 3. Graph of Risk Value Percentage

The results in Figure 1. explain the risk value for hazardous activities at PT. X, namely 33.33% is categorized into extreme risk, 21.33% is classified as high risk, and 12.00% is categorized into medium risk.

2. Measuring the Frequency of Disabled Injury

Measuring the frequency rate or the frequency of injuries with disabilities, the formula used is in accordance with equation 3, and the data used is the data in Table 6. The example of calculating the frequency rate in 2018 is:

$$,\mathrm{R}(2018) = 4{,}2438 \approx 5\text{per } 1.000.000 \text{ jam kerja} \quad (7)$$

$$\text{FR}(2018) = \frac{2x1.000.000}{51.840}$$

Based on these calculations, in the same way, the frequency rate recapitulation results are shown in Table 13. below:

Table 13. Recapitulation of Frequency Rate Calculation Results

Year	Amount Work accident	Frequency Rate (FR)
2018	22	4,2438≈5
2019	19	3,8807≈4
2020	16	3,7037≈4
2021	11	2,5463≈3
2022	10	2,3148≈3

The results of Table 13 above indicated that the highest calculation of the frequency of defect injury rates, namely in 2018, which was 4,24385≈5 per 1,000,000 working hours, and the lowest frequency rate was in 2022, which was 2,3148≈3 per 1,000,000 working hours, as shown in Figure 2. Following:

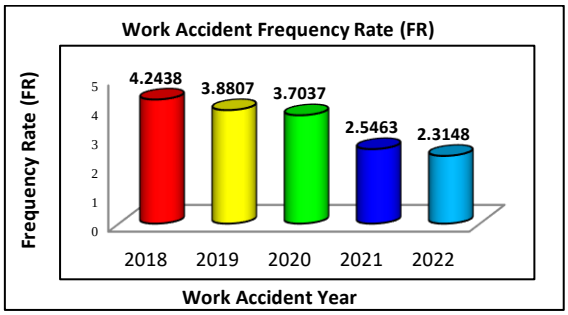

Figure 4. Frequency Level of Work Accident Rate (FR)

Figure 4. above shows that the frequency level for five years shows that in 2018, there were 4.2438≈5 frequencies of accidents caused by slipping and the operator's head hitting the FFB lorry; in 2019, there were 3.8807≈4 frequencies of accidents when pulling the door of the sterilizer the operator is exposed to steam pressure from inside the sterilizer, in 2020 there was 3.7037≈4 frequency of accidents caused by slipping and the operator's head hitting the TBS lorry and the operator's hand being pierced by a sling cable fiber, in 2021 there were 2.5463≈3 accident frequencies caused by slipping, pinching and the operator's head falling on the TBS lorry when raising the lorry to the register machine (empty fruit and TBS separator) and in 2022 there will be 2.3148≈3 of the frequency of accidents caused by slipping, getting stuck and being able to get punctured by sling cable fibers.

2. Measurement of Severity Rate.

Calculation of Severity Rate The formula used according to the equation in the previous four equations. An example of the calculation of the severity rate in 2018 is:

$$\text{SR}(2018) = \frac{400x1.000.000}{51.840} = 77.1604 \quad (8)$$

SR (2018) = 77 Hours per 1,000,000 hours worked
Based on these calculations, where the severity rate of the disability injury in 2018 obtained 77 hours lost per 1,000,000 working hours used, the overall Severity Rate results can be seen in Table 14, namely:

Table 14. Hasil Severity Rate

Year	Total Hours Lost (Hours)	Total Working Hours (Hours)	*Severity Rate* (Jam)
2018	400	51.840	77,16
2019	280	48.960	57,19
2020	224	43.200	51,85
2021	176	43.200	40,74

2022	160	43.200	37,03

Table 13 above shows that the measurement of the severity of disability injuries in 2018 was 77 hours lost per 1,000,000 hours of work used. In 2019, there were 57 hours lost per 1,000,000 hours worked. In 2020, there were 51 hours lost per 1,000,000 hours worked; in 2021, there will be 40 hours lost per 1,000,000 hours worked, and in 2022, there will be 37 hours lost per 1,000,000 hours worked, as shown in Figure 3, namely:

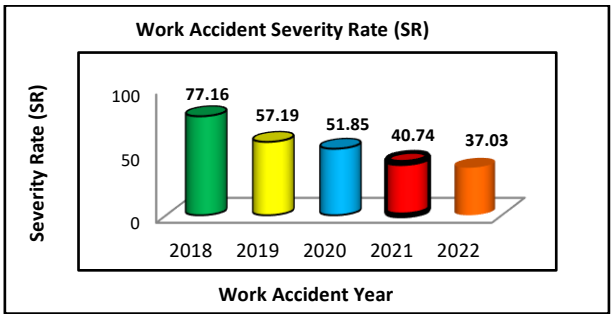

Figure 5. Work Accident Severity Level (SR)

Figure 5 above shows that the measurement of the severity of disability injuries in 2018 was 77 hours lost per 1,000,000 hours of work used; in 2019, there were 57 hours lost per 1,000,000 hours worked. In 2020, there were 51 hours lost per 1,000,000 hours worked. In 2021, there will be 40 hours lost per 1,000,000 hours worked, and in 2022, there will be 37 hours lost per 1,000,000 hours worked.

2. Calculation of Safe T Score (Sts)

The F1 score was used in the previous year, and the F2 score is the score that will be calculated, as shown in Table 15 below:

Table 15. Calculation of Happy T Score

Year	Total Working Hours (Hours)	F1	F2
2018	51.840	-	4,2438
2019	48.960	4,2438	3,8807
2020	43.200	3,8807	3,7037
2021	43.200	3,7037	2,5463
2022	43.200	2,5463	2,3148

Based on Table 15. Above, it can be compared to the score T survived, where the formula used according to the previous equation 7. The calculation method is as follows:

1. Score T Happy 2018
   Score T Happy Past (F1) is unknown, and the current T -survivor score (F2) is 4,2438, so the 2018 T Happy Score cannot be determined. This is because 2018 is the initial year of observation.
2. Score T Happy 2019
   Score T Happy Past (F1), namely 3,6811, and the current T -ADVANCE SCORE (F2) is 4,2438, so the calculation of the T Score Congratulations, namely:

$$TS(2019) = \frac{3,8807 - 4,2438}{\sqrt{\frac{4,2438}{48960}}} \quad (9)$$

Sts (2019) = - 1,2333

Based on these calculations, this shows an increase in work accident prevention achievements in 2019 compared to 2018, so the overall calculation of the Safe T Score (STS) is in Table 16. as follows:

Table 16. Recapitulation of Safe T Score

Tahun	Nts
2019	- 1,2333
2020	- 0,5905
2021	-0,5375
2022	-1,0643

Based on Table 16 above shows that there has been an increase in achievement in preventing work accidents in 2019 where the NTS value is negative, namely -1.2333, compared to the previous year, namely 2018, because in 2018, this cannot be determined because in 2018 it was the initial year of observation, for 2020 it shows that there has been an increase in accident prevention achievement again because the Sts value is negative with a Nts value of -0.5905, in 2021 it shows that there has been another increase in work accident prevention achievement with a negative Nts value of -0 .5375 while in 2022 it shows that there has been an increase in work accident prevention achievements with a negative Nts value of -1.0643.

Conclusions

The results of the highest accident risk assessment percentage at the sterilizer work station (boiling TBS) using the HIRARC method, namely the activity of pulling the sling cable on the winch, then attaching the hook to the lorry on the transfer carriage with 25 risk of accidents occurring with a percentage of 33.33% and categorized into extreme, for the second highest accident risk assessment, namely in the activity of withdrawing lorry using a winch and in the activity of pulling the sterilizer door and being lowered on the sterilizer bridge with the risk of work accidents as much as 16 times with a percentage rate of 21.33% and categorized into high incident and risk work accidents, namely in the activity of releasing the hook and carrying it then being put on the last lorry besides that also in the activity of pulling and carrying sling cables from the winch with an accident risk of 9 times the incidence of work accidents with a percentage rate of 12.00% and categorized into med ium incident.

Overcoming the risks that cause work accidents, namely Perform maintenance on hook and lorry hooks and cable slings, The company should replace a safer winch, Perform maintenance on bollard surfaces (cable sling rounds), Changing the steam sterilizer pressure parameter with a larger one, Operators must comply with work procedures when pulling the door of the sterilizer, The company must replace the safety glove that has been damaged, Perform routine track lorry cleaning, The company should replace a safer winch, Perform maintenance on bollard surfaces (cable sling rounds), The company should replace a safer winch, Perform maintenance on bollard surfaces (cable sling rounds), Perform maintenance on bollard surfaces (cable sling rounds).

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