ISSN 2962 - 2069
Journal of Industrial System Engineering and Management.

Journal of Industrial System Engineering and Management Vol 4 No 1 June, 2025

Analysis of Occupational Health and Safety Risks in the Palm Oil Processing Industry Using the HIRARC Method

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ARTICLE INFORMATION

Article history:

Received: May 11, 2025
Revised: May 30, 2025
Accepted: june 4, 2025

Keywords:
HIRARC,
Health and Safety,
Palm Oil,
Risk

ABSTRACT

The palm oil production industry is characterized by physically demanding tasks, high-temperature processes, and suboptimal working conditions, all of which contribute to a high risk of workplace accidents and health issues. At PT XX, 80% of reported work accidents are attributed to unsafe actions by workers, highlighting the need for a structured occupational health and safety management system. This study aims to identify hazards, assess occupational risks, and recommend appropriate control measures using the HIRARC (Hazard Identification, Risk Assessment, and Risk Control) method. Data were collected through field observations, interviews with 18 workers and 5 safety experts, and documentation across three key workstations: the loading ramp, sterilizer, and classification stations. The analysis identified a total of 15 work activities, with 3 classified as high-risk, 4 as medium-risk, and 8 as low-risk. High-risk activities were primarily related to exposure to high temperatures and confined workspaces. Control measures focused on engineering solutions, administrative controls, and the consistent use of Personal Protective Equipment (PPE). The study concludes that implementing the HIRARC framework significantly contributes to enhancing occupational health and safety in palm oil production environments

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INTRODUCTION

Occupational Health and Safety (OHS) is a discipline that focuses on preventing risks arising from work activities through hazard identification and implementing appropriate mitigation measures [1]. The goal of occupational safety and health is to establish a safe, healthy, and pollution-free workplace [2]. It aims also to enhance productivity and efficiency by eliminating occupational diseases and workplace catastrophes [3][4]. Occupational Safety and Health (OSH) aspects play an important role in running industrial production systems, including in the palm oil processing industry, which has a high level of work risk [5][6].

PT XX is a company operating in the palm oil production sector. The production activities, characterized by physically demanding tasks and suboptimal working conditions, may pose risks of occupational accidents and health problems if not adequately managed [7]. The company is committed to safeguarding employee health and safety while striving to achieve a zero-accident production system. Nonetheless, findings indicate that 80% of workplace accidents at PT XX are attributed to human factors, specifically categorized as unsafe actions. An unsafe actions refer to behaviors in the workplace that are either incorrect or deviate from established Standard Operating Procedures (SOPs) [8]. In the context of Health, Safety, and Environment (HSE), unsafe actions are defined as behaviors that diverge from prescribed safety procedures and are frequently associated with the occurrence of workplace accidents [9]. Such behaviors are shaped by a range of influencing factors, including personal attributes or utilizing Personal Protective Equipment (PPE), levels of knowledge, employee attitudes, and the quality of organizational leadership [10]. A comprehensive understanding of these contributing elements is essential for formulating effective preventive strategies aimed at reducing unsafe behaviors and improving overall workplace safety [11]. This presents a significant challenge for PT XX in maintaining occupational safety, given that the palm oil production process involves the operation of heavy machinery, exposure to high-temperature steam and hazardous chemicals, as well as suboptimal working conditions. Without proper management, these factors can substantially increase the risk of workplace accidents and pose serious threats to workers' health [12].

The current Occupational Health and Safety Management system implemented at PT XX is considered to be inadequate. This is evidenced by the persistence of potentially hazardous work activities and the absence of a structured approach to risk assessment at individual workstations. Furthermore, deficiencies in hazard identification data and the lack of comprehensive documentation of workplace accidents reflect the system's limited effectiveness. Although Personal Protective Equipment (PPE) has been provided to employees, its utilization has not been consistently monitored or enforced. Consequently, there is a critical need for an analytical method capable of systematically identifying, evaluating, and controlling occupational risks at every workstation within the facility. The Hazard Identification, Risk Assessment, and Risk Control (HIRARC) framework offers a structured methodology to enhance workplace safety by recognizing potential hazards, analyzing related risks, and applying appropriate control measures [13]. This method assists in identifying improvements and implement appropriate controls to prevent accidents in occupational health and safety situations [14]. Based on research by Aninditya et al [15], the application of the HIRARC method in of the installation work of the Jakarta-Cikampek Toll Road Package 3 South II project identified 17 risks classified as high risk and 8 dominant risks, which were then developed into effective control measures to enhance safety in the construction project. Similarly, a study applied the HIRARC model in a palm oil mill and identified 33 work activities across six workstations, with several classified as high-risk. The study concluded that the implementation of HIRARC was effective in evaluating and controlling occupational hazards, thereby supporting risk mitigation strategies and improving workplace safety performance in palm oil processing environments [16].

Aligned with these findings, the present study aims to identify hazards and assess the occupational risks involved in the palm oil production process at PT XX using the HIRARC method. Furthermore, the study seeks to formulate recommendations for risk control and prevention, particularly for activities that pose significant threats to the safety and health of workers. The proposed control measures are expected to contribute to the enhancement of workplace safety management and the establishment of a safer and healthier working environment within the company.

RESEARCH METHODS

This study employs a descriptive design utilizing both qualitative and quantitative approaches using the Hazard Identification, Risk Assessment, and Risk Control (HIRARC) method. Data collection was conducted through direct field observations, interviews with 18 workers and 5 safety experts, and documentation of workplace activities. The research specifically focuses on three key workstations within the palm oil production process at PT XX: the loading ramp station, sterilizer station, and the classification station. The loading ramp functions as a temporary storage area for Fresh Fruit Bunches (FFB) prior to further processing. The sterilizer station is where the FFBs are boiled for approximately 80 minutes at a temperature of 100°C until the fruit softens and breaks down. Lastly, the classification station is responsible for refining the extracted oil by separating it from the sludge, thereby producing high-quality crude palm oil.

The HIRARC process comprises the following three stages: hazard identification, risk assessment and risk control.

Hazard Identification

Hazard identification is a systematic effort aimed at recognizing and understanding potential risks associated with workplace activities and environmental conditions [17]. This process involves evaluating various operational scenarios to determine the presence of potential hazards. These scenarios typically include [18]:

a. Normal Operating Condition (N): Tasks performed in accordance with established procedures under standard conditions.
b. Abnormal Operating Condition (A): Tasks carried out under uncontrolled or non-standard circumstances, deviating from prescribed procedures.
c. Emergency Condition (E): Situations that are beyond control and require immediate response due to their potential to cause significant harm.

Risk Assessment

Following the identification of all potential risks, a risk assessment is carried out through comprehensive analysis and evaluation. The assessment involves determining the relative risk value, which is calculated by multiplying the likelihood score by the severity score [19]. The guidance of the likelihood and severity level showed in the Table 1 and 2.

Table 1. Likelihood/Probability Level

Level	Criteria	Description
1	Very Unlikely	Extremely unlikely to occur
2	Unlikely	May occur occasionally, but the probability is low
3	Possible	Could occur, but not frequently.
4	Likely	Occurs several times within a given period.
5	Very Likely	Expected to occur at any time.

Table 2. Severity Level

Level	Criteria	Description
1	Negligible	No injuries or financial losses
2	Slight	Minor injuries, with no serious consequences
3	Moderate	Hospitalized injury without permanent disability, moderate financial loss
4	High	Causes severe injury, permanent disability, major financial loss, and serious operational impact
5	Very High	Leads to fatalities, critical financial damage, and may permanently halt operations

Risk Control

Risk control measures are applied to all hazards identified during the hazard identification process, with consideration of the risk ratings to establish priorities and determine appropriate control strategies. In this regard, it is essential to follow the hierarchy of controls, which includes elimination, substitution, engineering controls, administrative controls, and the use of personal protective equipment (PPE) [20].

RISK MATRIX						
PROBABILITY →	Very Likely - 5	5	10	15	20	25
	Likely - 4	4	8	12	16	20
	Possible - 3	3	6	9	12	15
	Unlikely - 2	2	4	6	8	10
	Very Unlikely - 1	1	2	3	4	5
		1	*2*	*3*	*4*	*5*
		Negligible	*Slight*	*Moderate*	*High*	*Very High*
		SEVERITY →				

Risk	Risk Level	Action
1 to 6	Low Risk	May be acceptable but review task to see if risk can be reduced further
8 to 12	Medium Risk	Task should only be undertaken with appropriate management authorization after consultation with specialist personnel and
15 to 25	High Risk	Task must not proceed. It should be redefined or further control measures put in place to reduce risk. The controls should be

RESULTS AND DISCUSSION

Hazard identification was carried out for each activity at the three main workstations of PT XX, namely the loading ramp station, the sterilizer station, and the classification station. The results of the hazard and risk identification, the risk matrix and the controlling plan are presented in Tables 3 to 5.

Table 3. HIRARC's Template in Loading Ramp Station

No	Process	Hazard	Risk	Condition	Likelyhood	Severity	Risk Matrix
1	Weighing of Fresh Fruit Bunches (FFB)	Narrow workspace	Crushing injuries, shortness of breath	N	3	1	3
2	Transferring FFB to sorting area	Heavy load material	Injuries due to lifting or handling heavy objects	N	2	2	4
3	Unloading FFB from transport truck	Falling materials	Being struck by falling materials	N	3	2	6
4	Sorting and moving FFB to loading ramp gate	Stacked materials	Slipping, struck by falling materials	E	3	4	12
5	Cleaning the FFB transport truck	Slippery floor	Slipping, falling	A	1	2	2

Table 4. HIRARC's Template in Sterilizer Station

No	Process	Hazard	Risk	Condition	Likelyhood	Severity	Risk Matrix
1	Loading FFB into the scrapper	Material pile, slippery floor	Falling	N	2	1	2
2	Boiling process of oil palm fruits	High temperatures	Respiratory disorders, fire incident	N	4	4	16
3	Transferring boiled FFB to the screw press	Hot raw material	Hands were blistered and exposed to heat	N	4	4	16
4	Pressing process using the screw press	Hot raw material	Blistered and heat	E	4	3	12
5	Transferring oil to the vibro separator	Confined and cramped workspace	Crushed	A	3	3	9

Table 5. HIRARC's Template in Clasification Station

No	Process	Hazard	Risk	Condition	Likelihood	Severity	Risk Matrix
1	Separation of dregs using vibro separator	Confined workspace and pinch points	Respiratory disorders, hand caught in machine	E	3	2	6
2	Transfer of output to settling tank	Confined workspace	Respiratory disorders	E	3	3	9
3	Separation process using continuous settling tank	Confined workspace, tank leakage	Respiratory disorders, fire	E	4	4	16
4	Oil settling into crude oil tank	Confined workspace	Respiratory disorders	E	2	1	2
5	Cleaning of station after use	Slippery floor, slipping hazard	Slipping, injury	A	2	2	4

At the loading ramp station, there is one activity categorized as medium risk, namely sorting and moving fresh fruit bunches (FFB) to the loading ramp gate. The control measures implemented include routine cleaning of the area and the provision of material handling equipment to reduce material accumulation and to prevent slipping or being struck by falling materials. At the sterilizer station, there are two activities classified as high risk, namely the boiling process of oil palm fruits and transferring boiled FFB to the screw. For the boiling process of oil palm fruits, control measures include regular temperature monitoring and ensuring the proper functioning of the safety valve. As for the activity of transferring boiled FFB to the screw, the recommended controls are the use of personal protective equipment (PPE), specifically gloves, and ensuring that steam is fully released before opening the vessel door. At the classification station, one activity is identified as high risk, which is the separation process using the continuous settling tank. The implemented control measures include the use of PPE, specifically masks, and ensuring the availability of a fire extinguisher in the work area to prevent fire hazards.

CONCLUSION

The application of the HIRARC (Hazard Identification, Risk Assessment, and Risk Control) method in the palm oil production process at PT XX reveals that certain activities still pose significant risks to workers. An assessment of 15 activities across three main workstations, namely loading ramp, sterilizer, and classification identified three high-risk activities, four medium-risk activities, and the remainder categorized as low-risk. To address the high-risk activities, control measures are primarily focused on two key aspects: engineering controls and the proper use of personal protective equipment (PPE). These measures involve improving the physical conditions of the work area, conducting routine safety inspections, and fostering a strong safety culture by ensuring that workers consistently wear the required PPE.

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