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ORIGINAL ARTICLE

Hazard identification, risk assessment, and control at PT. Kharisma Iskandar Muda's Clarification Station: An HIRARC approach

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ABSTRACT

Occupational safety and health are critical for organizational stability and legal compliance. This study aims to identify hazards, assess risks, and develop control measures at the Clarification Station of PT Kharisma Iskandar Muda using the Hazard Identification, Risk Assessment, and Risk Control (HIRARC) method. This qualitative case study involved five informants, including an HSE officer, a process assistant, and station operators. The findings identified four key activities as major risk sources. Risks were classified into four levels: light (score 4), moderate (8), substantial (12), and extreme/unacceptable (20). Control measures were formulated based on the Hierarchy of Controls, ranging from elimination to Personal Protective Equipment (PPE). Specific recommendations include maintaining workplace cleanliness, conducting daily monitoring, installing safety signage, strictly adhering to Standard Operating Procedures (SOPs), and utilizing SNI-compliant PPE. The study concludes that relying solely on administrative controls is insufficient due to observed unsafe behaviors. Therefore, integrating engineering controls and fostering a strong safety culture are essential for effective risk management.

Keywords: HIRARC, hazard identification, risk assessment, risk control

INTRODUCTION

Occupational safety and health are essential factors that must be prioritized by all companies.[1] Workplace accidents do not occur randomly; they result from identifiable causes.[2] Occupational health and safety (OHS) issues have become increasingly important for organizations because they influence not only corporate reputation but also financial stability, legal compliance, and humanitarian considerations.[3] Accidents and other unexpected events may lead to production and operational disruptions, damage to property or assets, injuries, or environmental harm.[4]

The major causes of workplace accidents include human factors (such as fatigue, negligence, or failure to follow safety procedures) and physical factors, such as hazardous working conditions.[5] Workplaces, individuals, and technical equipment are the primary sources of occupational accidents.[6] Generally, two fundamental causes of these accidents exist: workplace hazards and issues related to employee health and well-being.[7] Research indicates that approximately 85% of workplace accidents stem from human factors.[2]

According to data from BPJS Ketenagakerjaan (Workers' Social Security Agency) in Aceh Province, unsafe work behaviors, inadequate supervision, and ineffective safety practices accounted for 105,182 workplace accidents in 2016, 80,392 in 2017, and 157,313 in 2018.[8] National data also show an upward trend, with the number of workplace accidents increasing from 15,486 in 2019 to 6,037 in 2020 and 7,298 in 2021.[9] The International Labour Organization (ILO) reports that more than 1.8 million people die each year in workplaces across Asia and the Pacific, while over 2.78 million deaths globally result from work-related diseases or accidents.[7]

One effective method for evaluating the potential occurrence of workplace accidents, classifying levels of risk, and implementing preventive actions is the Hazard Identification, Risk Assessment, and Risk Control (HIRARC) approach.[10] The HIRARC framework consists of three stages: hazard identification, risk

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assessment, and risk control.[11] Through systematic application of these steps, workplace accidents can be minimized.[9] Implementation of occupational safety and health (OHS) management begins with identifying potential hazards, followed by structured hazard assessment and the selection of appropriate control measures.[12]

PT. Kharisma Iskandar Muda (PT. KIM), located in Dusun Alue Gani, Gunong Pungki Village, Tadu Raya Subdistrict, Nagan Raya District, has been engaged in palm oil processing since 2012. The company employs 98 workers who operate across several stations, including the loading ramp, sterilizer, press, boiler, and clarification units. Despite existing safety measures, workplace accidents continue to occur, particularly at the Clarification Station. Previous research on HIRARC application in palm oil mills has been limited, especially in studies focusing on the Clarification Station within the Nagan Raya region of Aceh.

This study aims to address that gap by identifying specific hazards and assessing their risk levels under actual working conditions at the PT Kharisma Iskandar Muda Clarification Station. The study was conducted through direct observation and interviews with five informants: one key informant, three main informants, and one supporting informant. During operations, the Clarification Station recorded one workplace accident and two near-miss incidents. Therefore, this research applies the HIRARC approach to analyze occupational safety risks specific to the Clarification Station at PT Kharisma Iskandar Muda in Nagan Raya, Aceh.

METHOD

Study design

This study was conducted in the Clarification Station area at PT Kharisma Iskandar Muda, Nagan District, using a qualitative case study design over a four-month period from February to June 2024. The study involved five informants, including one key informant (Health, Safety, and Environment officer), one supporting informant (process assistant), and three main informants working at the Clarification Station. Qualitative methods were employed to analyze phenomena, conditions, and descriptive data through systematic, factual, and accurate evaluation of the investigated issues.[3]

The research applied the Hazard Identification, Risk Assessment, and Risk Control (HIRARC) approach to evaluate occupational accident risks. This method began with identifying potential workplace hazards during operational activities, followed by analyzing associated risks and formulating preventive strategies.[13] To avoid the emergence of new hazards, each phase of the HIRARC procedure emphasized the detection of potential risks and timely mitigation. The method consists of three main stages: hazard identification, risk assessment, and risk control.[14]

HIRARC method

The HIRARC framework provides organizations with a structured sequence of procedures to identify potential hazards arising from both routine and non-routine operations, assess the corresponding risk levels, and develop control measures to minimize hazards and prevent accidents.[15] The initial phase involves recognizing potential work-related hazards and implementing preventive actions to reduce their impact. The three HIRARC steps include hazard identification, risk assessment, and risk control.[16] Hazard identification was conducted through direct observation and semi-structured interviews with workers. Likelihood and severity values were established based on previous incident data and consultations with HSE personnel. Risk levels were determined using a standardized risk matrix according to AS/NZS 4360:2004.

Hazard identification

Hazard identification is a systematic approach used to recognize potential risks in workplace activities.[17] This process involves applying a structured method to facilitate comprehensive identification and analysis of all possible hazards.[18] Its objective is to determine activities or conditions that could lead to accidents or disrupt work operations.[19] Moreover, hazard identification serves as the foundation of workplace safety programs designed to minimize accident likelihood.[20]

Risk assessment

Risk assessment was conducted to evaluate the impact level of identified hazards.[21] Once all potential risks were identified, assessment and analysis were carried out using two parameters: likelihood and severity.[19] Likelihood refers to the probability of an adverse event occurring, while severity measures the potential consequences or level of harm resulting from such an event.[22] The combination of these two parameters determines the overall risk rating or risk level.[23]

Table 1. Likelihood criteria

Ranking	Criteria	Description
1.00	Unlikely	The event may occur only under exceptional circumstances, approximately once in five years.
2.00	Rarely	The event is possible under specific conditions, but unlikely within five years.
3.00	Possible	The event could occur under typical conditions, approximately once every three years.
4.00	Probable	The event may occur in most situations, roughly once a year.
5.00	Almost Certain	The event is expected to occur frequently, approximately every three months.

Source: Standard AS/NZS 4360:2004

Table 2. Severity criteria

Ranking	Criteria	Description
1.00	Insignificant	Minor injuries or illnesses treatable with first aid; no lost work time.
2.00	Minor	Minor injuries or illnesses requiring medical care; no lost work days, but temporary performance decline.
3.00	Moderate	Serious injury or illness requiring specialized treatment, resulting in lost work days.
4.00	Major	Permanent injury or disability due to workplace incidents.
5.00	Catastrophic	Multiple fatalities or permanent disabilities causing significant losses.

Source: Standard AS/NZS 4360:2004

Table 3. Risk matrix

Likelihood	Severity				
	1	2	3	4	5
1	T	T	A	A	A
2	T	A	M	M	S
3	A	M	M	S	S
4	A	M	S	U	U
5	A	S	S	U	U

Source: Standard AS/NZS 4360:2004

Table 4. Risk categories

Category	Score Range	Description
Trivial	1–2	No action required.
Acceptable	3–5	Monitoring required to maintain existing controls.
Moderate	6–9	Action required within 12 months to reduce risk.
Substantial	10–15	Action required within 6 months to reduce risk.
Unacceptable	16–25	Work must cease until the risk level is reduced within 7 days; administrative controls must be implemented immediately.

Source: Standard AS/NZS 4360:2004

Risk control

Risk control serves as the final phase in managing and mitigating workplace hazards.[17] Once the hazard level is determined, control planning focuses on eliminating or minimizing potential causes of workplace injuries and illnesses.[21] Five primary strategies are employed in risk management: elimination, substitution, engineering controls, administrative controls, and the use of personal protective equipment (PPE).[20]

Elimination involves permanently removing workplace hazards and should be prioritized whenever feasible. Substitution replaces hazardous materials or processes with safer alternatives to enhance operational safety. Engineering controls aim to reduce exposure through machine modifications, process redesign, or physical barriers. Administrative controls include developing and enforcing standard operating procedures (SOPs), safety signage, employee supervision, health checks, and work scheduling. Finally, PPE serves as a protective barrier for workers, reducing exposure severity when other control measures are insufficient. The consistent and correct use of PPE, aligned with safety standards and job requirements, plays a crucial role in safeguarding occupational health and safety.[20]

Data analysis

Data analysis followed the three-stage HIRARC framework, integrating qualitative data from direct observations (20 shifts across February–June 2024), semi-structured interviews with five informants, and HSE incident records (1 accident, 2 near-misses). Content analysis was applied to transcripts and field notes to identify recurring hazard themes, achieving thematic saturation after three interview cycles. Risk scores were computed quantitatively as likelihood (L; 1–5) × severity (S; 1–5), plotted on the AS/NZS 4360:2004 matrix for categorization (trivial: 1–2; acceptable: 3–5; moderate: 6–9; substantial: 10–15; unacceptable: 16–25).

RESULTS

Informant characteristics

Table 5 summarizes the demographic characteristics of the five informants who participated in this study, identified by the codes IK, IU 1, IU 2, IU 3, and IP. All participants were male. The ages of the informants ranged from 25 to 40 years. The key informant (IK) was 37 years old, while the supporting informant (IP) was the oldest at 40. The three main informants were relatively younger, with IU 1 aged 27, IU 2 aged 25, and IU 3 aged 29.

Table 5. Informant's characteristics

Characteristics	IK	IU 1	IU 2	IU 3	IP
Gender	Man	Man	Man	Man	Man
Age	37 years old	27 years old	25 years old	29 years old	40 years old
Address	Alue Geutah	Alue Gani	Gunong Keupok	Gunong Reubo	PT. KIM
Work period	2 years	5 years	3 years	4 years	2 years
Last education	Bachelor's in computer science	High School	High School	Bachelor's in economics	High School

In terms of educational background, the group included both university graduates and high school alumni. IK held a Bachelor's degree in Computer Science, and IU 3 held a Bachelor's degree in Economics. In contrast, IU 1, IU 2, and IP had completed education at the high school level. Their work experience within the company ranged from two to five years, reflecting adequate familiarity with the organizational environment. IU 1 had the longest tenure of five years, followed by IU 3 with four years and IU 2 with three years. Both IK and IP had worked for the company for two years. All informants resided in areas surrounding the company, specifically Alue Geutah, Alue Gani, Gunong Keupok, and Gunong Reubo. IP was the only informant who lived within the PT KIM complex.

Hazard identification

Based on the findings from observations and interviews conducted at the Clarification Station using the Hazard Identification, Risk Assessment, and Risk Control (HIRARC) approach, several potential hazards were identified in the work area of the Clarification Station.[19] The first stage of the HIRARC approach in data processing is problem identification.[21] Recognizing potential risks is a crucial component in maintaining worker health and safety.[7]

Table 6. Hazard identification

No.	Work activity	Hazard identification	Potential/impact	Photo area
1.	Stair climbing/ descending	1. Fall from stairs 2. Slip 3. Stumble	1. Head injury 2. Sprain 3. Fracture 4. Minor/serious injury	
2.	Floor cleaning in clarification area	1. Slip on oily floor 2. Fall 3. Collision	1. Head-floor impact 2. Sprain 3. Injury	
3.	Electrical panel operation	1. Electrocution 2. Explosion 3. Fire	1. Burns 2. Serious injury 3. Death	
4.	Crude palm oil sampling	1. Slipped in the hot oil area 2. Hot oil splash 3. Head struck by pipe	1. Sprain 2. Burns/blisters 3. Head injury	

Hazard identification at the Clarification Station of PT Kharisma Iskandar Muda, within the palm oil processing area, revealed four high-risk activities. These include ascending and descending stairs, which may result in falls; cleaning activities in the clarification area, where workers risk slipping on slippery floors; operating electrical panels, which poses a risk of electrocution; and collecting crude oil samples, which may expose workers to hot oil.

The interview results on hazardous work activities and occupational accident risks among workers at the Clarification Station revealed several key issues:

> Participant IU 1: "*The most dangerous tasks include climbing up and down the stairs to the oil tank and the Clarification Station Tank (CST). To prevent hazards, we regularly clean oil-spilled areas, especially when leaks occur. Operating the electrical panel in the clarification unit is also very risky. Additionally, collecting oil samples can be dangerous because of exposure to hot oil. For example, climbing the stairs to the oil tank can lead to slips, trips, or falls*."

> Participant IU 2: "*The hazardous activities include climbing stairs to the oil tank section, cleaning the clarification work area, operating the electrical panel in the clarification unit, and taking crude oil samples. These are considered the main potential hazards.*"

> Participant IU 3: "*When performing these tasks, such as climbing the stairs to the oil tank, workers are at risk of falling, slipping, or tripping. Cleaning the clarification area is also hazardous due to slippery surfaces, which is why we are always reminded to wear personal protective equipment (PPE). Other risky tasks involve operating the electrical panel, which could cause electric shocks, explosions, or fires. Furthermore, oil extraction in the clarification process can lead to splashes, increasing the risk of slips. We consistently work to minimize these risks and prevent spills*."

Risk assessment

Risk assessment followed hazard identification, evaluating likelihood (L) and severity (S) to compute risk scores (L × S) via matrix, classifying levels as acceptable, moderate, substantial, or unacceptable. Electrical panel operation posed the highest risk (score 20, unacceptable), driven by potential death from exposed cables.

Table 7. Risk assessment

Work Activity	Hazard/Potential Impact (abbrev.)	L	S	Score	Risk Level
Stair climbing/descending	Fall/slip/stumble (head injury, etc.)	4	2	8	Moderate
Floor cleaning	Slip/fall/collision (head impact, etc.)	4	1	4	Acceptable
Electrical panel operation	Shock/explosion/fire (burns, death)	4	5	20	Unacceptable
Crude palm oil sampling	Slip/splash/head strike (burns, etc.)	4	3	12	Substantial

Interview findings on the risk assessment of hazardous work activities at the Clarification Station revealed significant safety concerns:

> "*The most dangerous task involves operating the electrical panel, which can be fatal because the cables are exposed and have been damaged by rodents*" (IU1).

> "*When operating the electrical panel, carelessness may result in electric shock or electrocution. The most alarming hazard is the possibility of an explosion at the panel, which could injure the operator. There is also a risk of falling into hot liquid, particularly during sample collection. A previous incident occurred when a worker's foot slipped into hot liquid. The identified contributing factors include operating the electrical switch with wet hands or the presence of tools or other foreign materials inside the electrical panel, which may also trigger an explosion*" (IP).

> "*If an accident occurs at the electrical panel, the risk extends beyond the workers to damage factory property as well*" (IK).

Risk control

Risk controls, prioritized post-assessment, aimed to eliminate or minimize hazards per HIRARC hierarchy, targeting zero accidents through engineering, administrative, and PPE measures compliant with Indonesian National Standards (SNI). Interview findings regarding the control measures for hazardous work activities at the Clarification Station revealed several key points.

"We have provided education to operators and other personnel at the Clarification Station to ensure that they work in accordance with the established standard operating procedures (SOPs). We also provide training on occupational safety and distribute personal protective equipment (PPE) as a preventive measure when employees perform their tasks." (IP)

Table 8. Risk control

Work Activity	Key Controls
Stair climbing/descending	Proper SNI-compliant PPE; focus/concentration; clean oil spills; height training; standard operating procedures (SOPs); safety signage
Floor cleaning	Remove oil spills; SNI-compliant PPE; concentration; SOPs; safety signage
Electrical panel operation	Daily PPE checks (SNI-compliant); SOPs; concentration; protective gear; signage; training; occupational health and safety (OHS) education
Crude palm oil sampling	Concentration; SNI-compliant PPE; SOPs; signage; OHS education

"The use of PPE is mandatory. For example, the stairs must be cleaned frequently to prevent slipperiness, and the floors should be cleaned regularly, especially when oil spills occur. The floor is made of ceramic, which becomes slippery when wet, particularly during rain. We should also avoid placing unnecessary items inside electrical panels, as this could cause a fire. In addition, regular inspections are needed to identify any exposed wires." (IU1)

"To prevent workplace accidents, we conduct routine safety talks every morning during the briefing sessions, providing ongoing education until all operators fully understand occupational safety protocols. This includes both operators and helpers who are directly involved at the station. We also install various warning signs at the station, such as those prohibiting the placement of hazardous items inside panels and cautioning workers about slippery stairs." (IK)

DISCUSSION

HIRARC-based hazard identification revealed four principal work activities at the PT Kharisma Iskandar Muda Clarification Station posing occupational risks (Table 6). Stair-climbing exposes workers to falls, slips, and trips, yielding sprains, fractures, or minor to severe injuries, consistent with evidence of slippery surfaces precipitating falls and hot oil exposures in palm oil processing.[24] Floor cleaning in oily zones heightens slip, fall, and collision risks, resulting in head trauma or sprains.[25] Electrical panel operations involve electrocution, explosions, and fires, with outcomes including burns, severe trauma, or fatalities. Crude oil sampling entails slips near reservoirs, thermal splashes, and pipe impacts, causing sprains, burns, or cranial injuries.

These activities demonstrated graded risk profiles, one extreme (unacceptable), aligning with prior identification of electrical and sampling tasks as paramount threats in palm oil mills.[7] This study extends the literature by pinpointing behavioral factors, such as personal item storage in panels, as novel amplifiers. Field observations corroborated risks from oil-induced slips on stairs and floors, wiring defects, and thermal hazards. Such findings necessitate multifaceted OHS frameworks transcending administrative controls to encompass engineering, procedural, and cultural reforms; even minor hazards like oily surfaces demand rigorous management to forestall incidents.

Risk assessment quantified these via likelihood (L) × severity (S) matrices (Table 7), with electrical panels scoring 20 (unacceptable: L=4, S=5), crude sampling 12 (substantial: L=4, S=3), stair-climbing 8 (moderate), and floor cleaning 4 (acceptable). These levels mirror documented falls, burns, and dermal injuries in clarification settings (27, 28). Elevated electrical hazards trace to live exposures, humidity, absent inspections, rodents, and lapses like bottle storage, while sampling risks yield to SOPs and PPE. Contextual additions, including training deficits, surpass prior analyses[26], underscoring combined intrinsic, exposure, and control failures.

Controls followed Hierarchy of Control principles (elimination to PPE; Table 8), matching established protocols.[25,26] Electrical risks mandate enclosures, daily checks, SOPs, OHS training, and SNI-compliant

gear (gloves, helmets, goggles) under supervision. Sampling requires heat-resistant PPE, signage, and training. Stairs demand cleaning, warnings, height drills, and footwear. Cleaning involves spill protocols, PPE, and shift monitoring, with weekly panel audits and bi-daily cleanings. Observations affirm needs for signage and enforcement to secure zero accidents, informing scalable OHS policy in palm oil operations.

This qualitative case study was confined to a single clarification station, limiting generalizability across palm oil facilities or regions. Reliance on five informants and field observations may introduce subjectivity in L/S ratings, despite triangulation with incident data. Future longitudinal, quantitative studies incorporating worker surveys and pre/post-control metrics could validate these HIRARC findings and assess intervention efficacy.

CONCLUSION

This study identified four work activities at the Clarification Station of PT Kharisma Iskandar Muda that pose occupational safety risks, categorized by risk level as follows: acceptable (score 4), moderate (score 8), substantial (score 12), and extreme (score 20). The most hazardous activities involve potential electric shock, explosion, and fire, which may lead to serious injury or death. Risk control strategies are implemented in accordance with the Hierarchy of Control, including elimination, substitution, engineering controls, administrative measures, and PPE use such as SNI-standard helmets, gloves, shoes, and protective eyewear. These interventions are supported by workplace cleaning routines, regular inspections, safety signage, and active supervision to ensure a safe and accident-free work environment.

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