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Article

Occupational Health and Safety Risk Analysis Using The HAZOP Method at UD Kerupuk Mamak Kito

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A B S T R A C T

Occupational Health and Safety (OHS) is an approach designed to prevent workplace accidents that may cause death, injury, or disability. If potential hazards in the workplace are not adequately identified and managed, they can lead to fatigue, musculoskeletal disorders, injuries, or serious accidents. Due to the high-risk nature of its production processes and the lack of ergonomic considerations, the kerupuk processing industry at UD Mamak Kito must pay greater attention to Health, Safety, and Environment (HSE). One method to support OHS implementation is the HAZOP (Hazard and Operability Study) method, which systematically identifies potential hazards in the workplace. The study identified ten high-risk conditions, primarily associated with the use of personal protective equipment (PPE), ergonomics, and exposure to high heat or hot oil. Six moderate-risk conditions were also found, including failure to use PPE and minor environmental hazards. Low-risk factors, including minor cuts and slippery surfaces, were additionally observed. Based on these findings, recommended improvements include enhancing workplace conditions and promoting safer work practices to reduce the risk of accidents and occupational health problems.

1. Introduction

Crackers are a popular traditional snack in Indonesia, mostly made by small and medium businesses (SMEs). They're affordable and eaten across all social classes, both as snacks and with meals (Isrfansyah, 2024). One particular type, jangek crackers made from buffalo or cow hide, comes from West Sumatra and has become increasingly popular in other regions, creating good business opportunities (Debi et al., 2022). UD Mamak Kito in Pekanbaru is one of these small industries producing jangek crackers, though it hasn't grown much because there's limited interest in developing this sector.

Workers in food processing face various health and safety risks. They work with sharp knives, high temperatures, and often in poor conditions that can lead to muscle pain, injuries, and accidents (Midahayani, 2020). The government has regulations in place PP No. 50/2012 about OHS Management Systems and PP No. 21/2013 about OHS Training which require businesses to identify hazards, assess risks, and protect their workers. But many small food businesses don't follow proper safety procedures. Owners often skip providing safety equipment or training their workers, leaving them exposed to various dangers.

What's missing in current research is clear: most OHS studies look at large factories or SMEs in general, but very few examine the specific safety issues in traditional food production, especially in cracker making. Also, while the HAZOP (Hazard and Operability Study) method is commonly used to analyze risks in chemical plants and large industries, it's rarely been applied to small traditional food businesses. Most safety assessments in SMEs just use basic checklists or simple observations instead of thorough, systematic analysis.

This study fills that gap by using HAZOP to identify and assess safety hazards at UD Mamak Kito's jangek cracker production. By adapting HAZOP which was designed for complex industrial settings to fit a small traditional food business, this research provides new insights into: (1) the specific hazards found in artisanal cracker making, (2) whether structured risk assessment methods can actually work in small businesses with limited resources, and (3) practical ways to reduce risks that suit traditional food operations. These findings should help shape better OHS policies and practices for similar small food businesses across Indonesia.

2. Literature Riview

2.1 Accupational Healt And Sfety (K3)

Occupational Health and Safety (OHS) is more than just a set of rules or definitions it's about understanding how workplace systems, human behavior, and environmental conditions all interact with each other. Muttaqin (2021) explains that OHS involves how companies systematically manage people, machines, materials, and work methods to prevent accidents and injuries. While this gives us a basic framework, we need to dig deeper into how accidents actually happen, why workers behave the way they do, and what responsibilities organizations really have in keeping people safe.

Work accidents don't just happen randomly they're usually the result of several factors coming together within how a company operates. The ILO-WHO Joint Committee on Occupational Health points out that good OHS programs need to look after workers' physical health, mental state, and social well-being, while making sure work conditions match what people can actually handle physically. This broader view shows us how the decisions management makes can directly affect how workers behave and whether accidents happen. Take this example: when companies don't provide proper safety training, the right equipment, or workspaces designed with ergonomics in mind, they're actually setting up situations where workers are more likely to do unsafe things, which then leads to accidents.

To understand why accidents happen, we need to look at how organizational culture, safety systems, and individual actions are connected. Unsafe working conditions and human error are often blamed for workplace accidents, but these things rarely exist on their own. More often, they point to deeper problems in how organizations assess risks, allocate resources, or build safety culture. When companies talk about OHS but don't actually implement real programs, there's a disconnect between what they say and what they do and workers feel this gap in their daily work. Employees working in places with poor safety protocols often develop unsafe habits, not because they're careless, but because they're adapting to the flaws in the company's safety system.

Effective OHS management necessitates recognition of the dynamic interplay among organizational commitment, environmental design, and worker engagement. Organizations that integrate OHS into their operational framework, rather than relegating it to compliance obligations, establish workplace environments where safe behaviors constitute normative practice. This holistic approach recognizes that workplace hazard protection encompassing workers, organizational assets, operational environments, and community stakeholders—requires systematic intervention across organizational practices, environmental parameters, and behavioral patterns that collectively influence safety outcomes.

The foundation of effective OHS management lies in recognizing how organizational commitment, environmental design, and worker engagement interact dynamically in preventing workplace accidents. When organizations embed OHS within their operational frameworks as essential requirements rather than ancillary responsibilities, they cultivate workplace environments where safe practices become standard behavioral norms. Such an integrated strategy demonstrates that comprehensive hazard protection safeguarding employees, organizational assets, workplace environments, and surrounding communities requires interventions that extend beyond isolated risk factors to encompass the broader matrix of organizational procedures, environmental parameters, and behavioral patterns shaping safety outcomes.

2.2 Hazard And Operability Study (HAZOP)

Hazards are defined as conditions or circumstances that increase the probability of harm or loss from specific adverse events. Elevated loss potential arises from multiple sources, including inadequate maintenance practices, deteriorated road infrastructure, insufficient machinery upkeep, and unsafe workplace environments (Darmawi, 2016). Effective mitigation or elimination of workplace accident hazards, as noted by Restuputri and Sari (2015), requires implementing systematic risk management frameworks that incorporate hazard identification, potential hazard analysis, risk assessment, risk control measures, and continuous monitoring and evaluation.

1. **Selection of Risk Assessment Methodology**
   Contemporary risk assessment practice encompasses multiple methodologies for hazard identification and analysis, each characterized by distinct operational features and optimal application contexts. Three established approaches warrant detailed consideration:
2. **Job Safety Analysis (JSA)** functions by disaggregating individual work tasks into constituent sequential steps, thereby enabling systematic identification of step-specific hazards. This approach proves particularly suitable for routine, task-centered operations where worker actions represent the primary analytical concern. JSA application remains bounded, nevertheless, by its focus on isolated job procedures, which may prove inadequate for capturing system-level dynamics or process deviations present in operationally complex environments.
3. **Failure Mode and Effects Analysis (FMEA)** proceeds through systematic investigation of potential component or equipment failure scenarios and subsequent evaluation of their systemic performance implications. FMEA demonstrates notable capability in equipment reliability analysis and component-failure characterization, establishing its utility for maintenance optimization and design refinement purposes. The methodology's predominant hardware orientation, however, risks underemphasizing operational variations or human-system interface considerations central to process-based operations.
4. **Hazard and Operability Study (HAZOP)** offers a structured analytical framework for examining process systems whether planned or operational to identify and assess conditions presenting personnel hazards, equipment risks, or operational efficiency impediments. Though originally formulated for chemical process industries, HAZOP has achieved successful adaptation across diverse system categories and complex operational contexts, including thermal systems such as boilers, enabling

systematic documentation of process deviations alongside their resultant consequences.

5. **Justification for HAZOP Selection**

HAZOP methodology was selected as the primary analytical framework for this investigation based on its distinctive capabilities relative to alternative risk assessment approaches. Unlike JSA's task-decomposition strategy or FMEA's equipment-failure orientation, HAZOP provides a process-centric analytical structure particularly well-suited to complex operational systems where multiple variables interact concurrently. The methodology's guideword-based interrogation technique employing systematic prompts including "more," "less," "no," and "reverse" enables comprehensive exploration of potential operational deviations, revealing hazard scenarios that may elude detection through conventional assessment methods.

HAZOP's collaborative analytical structure represents a fundamental methodological strength. As Ningsih (2019) notes, the approach leverages structured multidisciplinary team interaction to achieve hazard identification outcomes superior to those obtainable through independent expert analysis followed by result compilation. This team-based framework (HAZOP Team) capitalizes on diverse professional perspectives to enhance identification comprehensiveness beyond individual analytical reach. Additionally, HAZOP provides integrated analysis encompassing causal factor identification, consequence evaluation, and control measure recommendation offering a holistic risk management framework rather than isolated hazard cataloging.

While JSA demonstrates clear utility for discrete task analysis and FMEA offers advantages in equipment reliability assessment, HAZOP's process-deviation methodology coupled with collaborative multidisciplinary analysis presents optimal alignment with this study's research objectives: systematic identification and comprehensive analysis of operational hazards within skin cracker production processes at UD Mamak Kito. The methodology's combination of analytical rigor and procedural flexibility facilitates detailed examination of deviation-to-hazard pathways, thereby informing development of risk control interventions appropriate to traditional food manufacturing contexts.

2.3 Ergonomics

Nurmianto (2005) conceptualizes ergonomics as the systematic study of human dimensions within work environments, examined through multiple disciplinary lenses encompassing anatomy, physiology, psychology, engineering, management, and design. The field addresses optimization of operational efficiency, advancement of health and safety standards, and enhancement of human comfort across diverse settings including workplaces, domestic environments, and other human-occupied spaces. Simanjuntak (2022) articulates the fundamental ergonomic principle as adaptation of work requirements to worker capabilities. Tarwaka (2015) provides a more comprehensive definition, characterizing ergonomics as an integrative discipline combining scientific knowledge, practical application, and technological implementation to achieve equilibrium between facilities utilized for work and rest activities and the inherent physical and cognitive capabilities and constraints of human operators, ultimately serving to enhance overall quality of life.

1. **Ergonomic Principles in Workplace Application**

The application of ergonomic principles within occupational contexts functions to establish optimal worker comfort conditions, consequently enhancing operational productivity. Ergonomic implementation in workplace settings operates across four foundational dimensions that provide the conceptual framework for postural risk evaluation conducted in this study:

a. **Work methodology and task execution** – This dimension examines the procedural approaches through which workers accomplish occupational tasks and the operational requirements that govern movement patterns during task performance.

b. **Postural dynamics and biomechanical loading** – This component addresses the body positions, kinematic patterns, and joint angles workers adopt during task execution, alongside the biomechanical stresses these postures impose on musculoskeletal structures.

c. **Tool-human interface characteristics** – This aspect investigates the equipment and implements employed by workers, analyzing how tool design parameters influence required body positioning and resultant movement sequences.
d. **Health and comfort outcomes** – This dimension evaluates the physiological responses and musculoskeletal consequences stemming from work-related factors, assessing their aggregate impact on worker health and occupational comfort.

2. Theoretical Foundation of Postural Risk Analysis

The nexus between ergonomic principles and postural hazards derives from established biomechanical and physiological theories. The human spine and musculoskeletal architecture exhibit intrinsic structural limitations that circumscribe safe postural boundaries in occupational contexts. Extensive research has delineated critical angular thresholds for specific anatomical segments:

a. **Spinal flexion parameters**: Forward trunk deviation exceeding 20° from neutral positioning elevates compressive loading on intervertebral disc structures while generating muscle strain, with these effects amplified substantially during sustained postures maintained beyond 30-minute durations.
b. **Cervical flexion constraints**: Anterior head inclination surpassing 15° produces marked increases in cervical vertebral loading, with biomechanical analyses indicating each incremental degree of forward head posture contributes approximately 4.5 kg additional perceived loading to cervical support structures.
c. **Postural deviation impacts**: Occupational postures incorporating trunk rotation, lateral flexion, or asymmetrical load bearing compromise optimal spinal alignment, thereby augmenting musculoskeletal disorder (MSD) susceptibility through disrupted load distribution patterns.

From physiological perspectives, static postural maintenance or repetitive non-neutral positioning compromises muscular blood flow, hastening metabolic byproduct accumulation particularly lactate and inducing accelerated muscular fatigue onset. When workplace postural requirements exceed biomechanical tolerance parameters through excessive articular angles, extended static loading durations, or elevated-frequency repetitive motion, cumulative tissue strain manifests progressively as discomfort sensations, pain responses, diminished productive capacity, and eventual chronic MSD development.

3. Analytical Framework for Postural Risk Assessment

The biomechanical and physiological theoretical foundations presented previously inform the methodological approach employed for postural risk analysis in this study. The ergonomic assessment framework operationalizes these principles across four analytical dimensions:

a. **Postural deviation measurement**: This component quantifies the extent to which observed occupational postures diverge from biomechanically neutral positions. Analysis utilizes angular threshold values established in ergonomic research literature as normative reference points, facilitating systematic comparison between actual postural configurations and evidence-based safety parameters.
b. **Temporal exposure assessment**: This dimension characterizes both durational and frequency-based aspects of postural exposure. Evaluation encompasses time intervals during which workers sustain non-neutral postures alongside recurrence rates of repetitive motion patterns, acknowledging these temporal variables as principal determinants of accumulated biomechanical stress.
c. **Workstation ergonomic compatibility**: This analytical component evaluates whether workplace equipment design and spatial configuration compel workers to adopt awkward postures. Assessment examines potential incongruence between occupational task requirements and human biomechanical capabilities arising from ergonomic design inadequacies.
d. **Symptom-exposure correlation**: This validation dimension systematically associates measured postural deviations with worker-reported musculoskeletal symptomatology and discomfort experiences. Analysis establishes empirical

connections between documented ergonomic violations and manifested health consequences, validating theoretical postulated relationships between postural risk factors and adverse health outcomes.

4. Integration with HAZOP Analysis

The synthesis of ergonomic theory with HAZOP methodology enhances risk identification capacity by establishing a systematic analytical framework for postural hazard evaluation. Although HAZOP conventionally addresses process deviations in industrial operations, its adaptation to ergonomic assessment redirects analytical focus toward deviations from optimal postural parameters. HAZOP guidewords facilitate structured interrogation of ergonomic conditions:

Excessive angular displacement ("MORE" flexion than biomechanically acceptable thresholds) correlates with elevated musculoskeletal disorder (MSD) risk through increased tissue loading. Extended temporal exposure ("LONGER" duration maintaining static postures beyond recommended intervals) accelerates muscular fatigue onset via impaired circulatory exchange. Absence of postural variation ("NO" position changes throughout work periods) sustains continuous biomechanical loading on identical anatomical structures. Non-neutral segmental positioning ("REVERSE" or awkward body segment orientation) generates asymmetrical strain distribution patterns across musculoskeletal tissues.

This theoretical synthesis ensures subsequent postural risk analysis transcends mere descriptive observation, achieving analytical rigor grounded in established ergonomic principles. Explicit connection of observed postural behaviors to biomechanical theory enables identification of specific ergonomic violations, evidence-based prediction of health consequences, and development of interventions targeting causal mechanisms rather than symptomatic manifestations. Workplace observation findings undergo interpretation through this ergonomic theoretical lens, facilitating establishment of causal relationships linking workplace design characteristics, postural demand parameters, and worker health outcomes.

3. Research Methodology

This research was conducted at UD Mamak Kito, an agro-industrial small and medium enterprise located in Sialang Munggu Village, Tuah Madani District, Pekanbaru City, within the Cipta Karya area. The study was carried out over a seven-month period, from January to July 2025. Hazard identification and risk evaluation were performed using the Hazard and Operability Analysis (HAZOP) method to systematically examine potential occupational hazards associated with the skin cracker production process.

The HAZOP method was selected for its structured and systematic framework, which enables thorough hazard identification and risk assessment, particularly in small-scale industrial environments where formal occupational health and safety (OHS) management systems are often inadequately implemented. Furthermore, a quantitative descriptive research design was employed to characterize existing working conditions, operational procedures, and associated risk levels within the workplace. Data were collected through direct field observations, semi-structured interviews, and document analysis. The use of multiple data collection techniques facilitated data triangulation and contributed to the reliability and validity of the research findings.

Prior to the hazard identification stage, a comprehensive review of the skin cracker production workflow at UD Mamak Kito was conducted to obtain an in-depth understanding of each operational step. The production process consists of nine principal activities, commencing with cowhide sorting and ending with the final packaging stage. This process mapping provided a systematic basis for identifying potential hazards associated with each stage of production.

Table 1. Production process

No	Production Process Sequence
1	Cowhide Sorting
2	Cowhide Washing
3	Cowhide Removal/Scraping
4	Cowhide Boiling
5	Cowhide Cutting Into Squares
6	Cowhide Drying
7	LATUA Process (using oil and wter, repeated 7x)
8	Cracker Friyng
9	Packing

The steps taken to identify potential risks using the Risk Assessment Sheet and HAZOP can be outlined as follows:

1. Understand the production procedures or processes taking place at UD Mamak Kito (see Table 1).
2. Identify potential hazards that may arise during the research.
3. Complete the required components of the HAZOP Worksheet in the following order:
   a. Identify potential hazards found during the research site visit.
   b. Describe deviations that occurred during the production process.
   c. Explain the primary cause of the deviations (causes).
   d. Describe the possible consequences of these deviations (consequences).
   e. Determine possible temporary actions or measures.
   f. Assess the hazard level based on the Likelihood (L) criteria (see Table 2) and Impact (Consequences - C) (see Table 3).
   g. Develop solutions or recommendations for improvements to risks with the highest severity.

Table 2 and Table 3 show the Likelihood and Consequences criteria.

Table 2. Likelihood Criteria

Level	Description	Description	
		Severity of Injury	Working days
1	Not Significant	Does not cause any loss	Does not eliminate lost work days
2	Small	Causes small losses, does not have much impact	Missed work days around 1 day
3	Currently	There is a possibility of being taken to the hospital. The damage is quite severe.	Missed working days less than 3 days
4	Heavy	Causes serious injury, considerable loss	Missed work days of more than 3 days
5	Disaster	Menimbulkan korban jiwa dan banyak kerugian	Causing loss of life and much damage

Sumber: UNSW Health and Safety

Table 3. Consequences Criteria

Level	Criteria	Deskription	
		Qualitative	Semi Qualitative
1	Seldom	It can be expected to occur within a certain time period.	Occurs less than once in 10 years
2	Small Chance	Not yet happened, but may appear or occur at some time	Occurs once every 10 years
3	Possible	Allows to appear multiple times	Occurs 1x every 5 years to 1x per year
4	Most likely	Most likely it can appear at certain times	Occurs more than 1x per year to 1x per month
5	Almost Certain	Frequent occurrence, expected to occur in consistent circumstances	occurs more than once per month

1. Justification of Likelihood and Consequence Criteria

The likelihood and consequence scoring criteria employed in this study were adapted from the University of New South Wales (UNSW) Health and Safety risk assessment guidelines, which are widely acknowledged and applied in occupational risk assessment practices. Likelihood criteria were used to estimate the probability of a hazard occurring within a defined period, ranging from rare occurrences to events that are considered almost certain. The determination of likelihood scores was informed by the frequency of worker exposure, prevailing operational conditions, and historical information obtained from interviews with both workers and management.

Consequence criteria were applied to evaluate the severity of potential impacts on workers and business operations, including the magnitude of injury, the number of lost working days, and the potential for fatal outcomes. Consequence scores were assigned based on the most severe, yet reasonably foreseeable, consequences should a hazard occur, in accordance with established principles of occupational health and safety risk assessment.

Risk is assessed using likelihood criteria, among other factors. Likelihood criteria are a measure of the probability of a workplace accident occurring within a given time period. These criteria, as listed in Table 2, are ranked from 1 to 5, with the following breakdown: level 1 means rare, level 2 is unlikely, level 3 is possible, level 4 is probable, and level 5 is almost inevitable.

The severity of the consequences depends on the extent to which the hazard source affects the conditions of the employees and the operations of the business involved. The next step after identifying potential hazards using the HAZOP Worksheet is to multiply the Likelihood (L) value by the Impact (C) value. The hazard potential is then classified by applying the result to the risk matrix evaluation.

Figure 1. Risk Matrix
Source: UNSW Health and Safety

4. Results and Discussion

The next step was to conduct direct observations at the research site and interview the business owner after understanding the sequence of the skin cracker production process at UD Mamak Kito. Through interviews and direct observations, various hazards and potential risks were identified at the skin cracker production site. Risk scores for each identified hazard and potential risk were then calculated using the HAZOP method, as shown in Table 4.

The hazards posed by the skin cracker production process include, as shown in the risk score calculation in Table 4, the following:

a. High Risk: Ten high-risk incidents, primarily related to ergonomics, the use of personal protective equipment (PPE), and exposure to high temperatures or hot oil.
b. Medium Risk: Six incidents involving improper use of PPE, lifting of heavy objects, and minor environmental risks.
c. Low Risk: Six low-risk incidents, such as slippery surfaces or minor injuries, can be controlled with simple handling methods.

Table 4. Potential Hazard Finding Level Score

No	Process	Hazard's findings	Risk	Hazard Source	L*	C*	S*	Risk Level
1	Cowhide Sorting	Cut while sorting cowhide	Luka terbuka	Knife/cutter, hard cowhide	2	1	2	Rendah
2	Cowhide Washing	Slippery floor when washing cowhide	Bone Injury	Slippery floor	2	2	4	Rendah
		Worker positions are not ergonomic (bending and repetitive movements)	Musculoskeletal Complaints	Worker Attitude	4	2	8	Tinggi
3	Cowhide Removal/ Scraping	Non-ergonomic worker positions (bending and repetitive movements)	Musculoskeletal Complaints	Worker Attitude	5	2	10	Tinggi
		Cut during the scraping process	open wound	Knife/cutter, hard cowhide	2	1	2	Rendah
		Not using PPE (gloves, masks, shoes))	Shortness of breath, open wounds	Worker Attitude	3	2	6	Sedang
4	Boiling Cowhide	Slippery floor due to spilled boiled water	Bone Injury	Working Environment Conditions	3	2	6	Rendah
		Exposed to hot water and hot production room	Burns, fatigue	Working Environment Conditions	3	2	6	Sedang
		Burns during boiling	Burns	Working Environment Conditions, hot steam, boiling water	4	3	12	Tinggi

No	Process	Hazard's findings	Risk	Hazard Source	L*	C*	S*	Risk Level
		Not using PPE (gloves, masks, shoes)	Shortness of breath, open wounds	Working Environment Conditions	3	2	6	Tinggi
5	Cutting the Leather into Squares	Cut while cutting cowhide	open wound	Knife/cutter, smooth cowhide	2	2	4	Rendah
		Worker positions are not ergonomic (bending and repetitive movements)	Musculoskeletal Complaints	Worker Attitude	5	2	10	Tinggi
		Not using PPE (gloves and masks)	Shortness of breath, open wounds	Working Environment Conditions	3	2	6	Sedang
6	Drying Process of Cut Skin	Lift the drying basket	Musculoskeletal Complaints	Worker Attitude	4	1	4	Sedang
		Not using PPE (gloves and masks)	Shortness of breath, open wounds	Working Environment Conditions	2	1	2	Rendah
7	LATUA process (using oil and water repeated 7 times)	Irritation from oil or water mixed with latua process	Irritation, inflammation wounds	hot oil	4	2	8	Tinggi
		Not using PPE (gloves, masks and shoes)	Shortness of breath, burns	Working Environment Conditions	3	2	6	Tinggi
		Hot production room	Uncomfortable, easily tired	Working Environment Conditions	3	1	3	Rendah
8	Cracker Frying	Hot oil splashes while frying	Burns	hot oil	4	2	8	Tinggi
		Working in a standing position for too long	Musculoskeletal Complaints	Worker Attitude	4	2	8	Tinggi
		Hot production room	Uncomfortable, easily tired	Working Environment Conditions	3	1	3	Rendah
		Not using PPE (gloves, masks and shoes)	Shortness of breath, burns	Working Environment Conditions	3	2	6	Sedang
9	Packing Process	Worker positions are not ergonomic (bending and repetitive movements)	Musculoskeletal Complaints	Worker Attitude	4	2	8	Tinggi

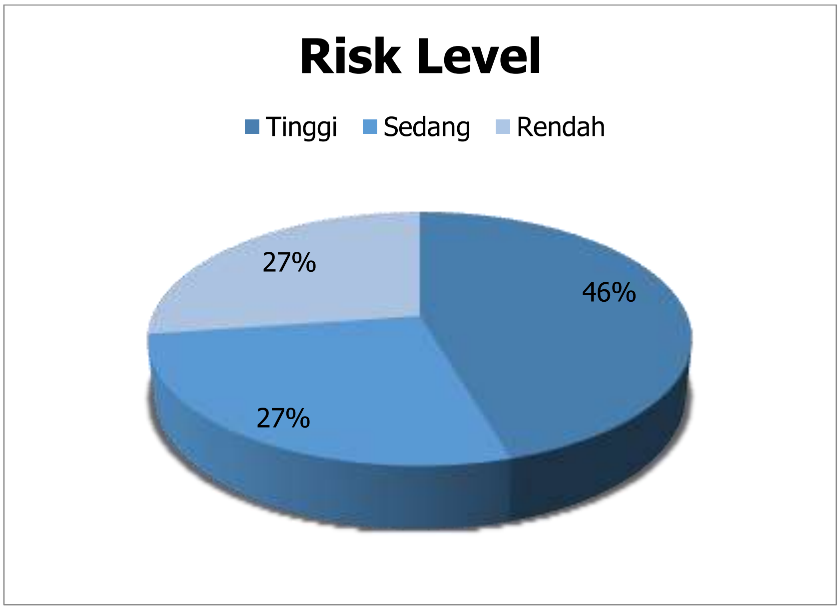

Figure 2. Risk level

The findings of the risk assessment, as presented in Table 4 and Figure 2, indicate that 46% of the identified hazards in the skin cracker production process are categorized as high risk, while 27% are classified as medium risk and the remaining 27% as low risk. This distribution suggests that nearly half of the production activities present substantial occupational health and safety risks, thereby necessitating immediate and prioritized control measures.

High-risk hazards were predominantly associated with ergonomic factors, thermal exposure, and non-compliance with the use of personal protective equipment (PPE). Ergonomic risks primarily arise from non-ergonomic working postures, including prolonged bending, repetitive manual handling of heavy loads, and extended periods of standing without sufficient rest. Such conditions are commonly observed in small-scale food processing enterprises, where production activities rely heavily on manual labor and ergonomic workstation design is seldom applied. Similar findings have been reported by Mindhahayani (2020) and Nurmianto and Iridiastadi (2018), who identified inadequate workstation design and repetitive manual tasks as major contributors to musculoskeletal disorders among workers in small and medium-sized enterprises (SMEs).

Thermal hazards, including exposure to hot water, steam, and hot oil during the boiling, softening (Latua), and frying stages, also contributed substantially to the high-risk classification. The lack of engineering control measures, such as thermal insulation, physical protective barriers, and adequate ventilation systems, increases the likelihood of burn injuries and heat-related stress. This observation is consistent with previous studies on traditional food processing industries, which have reported that direct exposure to heat sources combined with insufficient thermal protection represents a common cause of occupational injuries in small-scale production settings (Sutrisno et al., 2019).

Non-compliance with the use of personal protective equipment (PPE) further amplifies the severity of occupational risks. In this study, several hazards classified as high and medium risk were associated with the improper or absent use of PPE, including heat-resistant gloves, respiratory masks, and protective footwear. This condition may be attributed to limited safety awareness among workers, discomfort associated with PPE use in high-temperature working environments, and inadequate supervision and enforcement of occupational safety regulations. Similar findings were reported by Putri and Santoso (2021), who noted that PPE non-compliance in small and medium-sized enterprises (SMEs) is strongly influenced by informal workplace cultures and insufficient occupational safety training.

Medium-risk hazards were primarily related to improper manual handling practices, partial compliance with PPE requirements, and minor environmental hazards. Although these risks may not lead to immediate severe injuries, prolonged or repeated exposure has the potential to cause chronic health problems and decreased work productivity if not adequately controlled. Low-risk hazards, such as slippery floor conditions and minor cuts, can generally be mitigated through relatively simple measures, including improved housekeeping practices, regular floor maintenance, and basic safety education.

The observed risk patterns are closely associated with the structural characteristics of SMEs, including limited financial capacity, the absence of formal occupational health and safety management systems, minimal investment in safer technologies, and continued reliance on traditional production methods. Consistent with this observation, the International Labour Organization (ILO, 2015) and Tarwaka (2017) have reported that such constraints often lead SMEs to prioritize production continuity over occupational safety considerations, thereby increasing workers' exposure to workplace hazards.

Overall, the findings of this study corroborate previous research and underscore that ergonomic risks, thermal exposure, and non-compliance with PPE use remain persistent occupational safety challenges in small-scale food processing industries. These findings emphasize the need for the implementation of context-appropriate and feasible risk control strategies for SMEs, including ergonomic improvements, the gradual adoption of engineering controls, enhanced occupational safety training, and stricter enforcement of PPE usage. Strengthening these measures is expected to reduce occupational risks, improve worker well-being, and support more sustainable production practices.

This study demonstrates that the skin cracker production process is characterized by a variety of occupational hazards, a substantial proportion of which are classified as high risk based on the HAZOP analysis. The most significant risks are related to non-ergonomic working postures, exposure to elevated temperatures, substandard workplace conditions, and inadequate compliance with the use of personal protective equipment (PPE).

These findings indicate that routine production activities in small-scale food processing industries entail considerable occupational health and safety (OHS) challenges, which may lead to long-term adverse health outcomes in the absence of appropriate control measures.

Furthermore, this research contributes to the enhancement of OHS practices in small-scale food processing industries by employing a structured and systematic approach to hazard identification and risk prioritization through the HAZOP method. The empirical evidence generated provides a sound basis for the development of practical and context-specific safety interventions that account for the operational constraints and distinctive characteristics of small and medium-sized enterprises (SMEs), where formal OHS management systems are frequently underdeveloped or absent.

5. Conclusion

Every production process carries risks that may not be immediately apparent but can have long-term impacts if not promptly addressed. After conducting a HAZOP analysis, recommendations or proposed improvements are provided to address the potential hazards identified. However, implementation can be prioritized based on the highest risk level. Some suggested improvements based on potential hazards include:

a. Worker Attitudes and Behaviors
Working postures should be progressively adjusted toward more ergonomic configurations in order to reduce the risk of musculoskeletal disorders. Regular occupational health and safety training programs are also recommended, with particular emphasis on the correct and consistent use of personal protective equipment (PPE). Visual communication tools, such as instructional posters and PPE usage guidelines, should be prominently displayed in production areas to enhance safety awareness and encourage mutual supervision among workers. In addition, the establishment of clear safety rules accompanied by proportionate enforcement mechanisms is necessary to improve compliance with established safety procedures.

b. Work Environment Improvements
Production areas should be thoroughly cleaned after each production cycle to prevent the emergence of secondary hazards. The implementation of engineering control measures, including the installation of ventilation systems and the provision of mechanical fans, is recommended to mitigate excessive heat exposure. Adequate PPE such as masks, protective gloves, and safety footwear should be consistently provided and made readily accessible to all workers.

c. Operational Control and Housekeeping
Spills of raw materials, water, and hot oil should be promptly addressed and removed following the completion of work activities to prevent slip and burn hazards. Furthermore, small-scale enterprises are encouraged to develop simple, clearly documented guidelines for safe production practices in order to minimize recurring hazards and enhance overall workplace safety performance.

By prioritizing control measures based on the level of risk severity, these recommendations offer a practical and context-appropriate framework for improving occupational safety in small-scale food processing industries, while remaining feasible within the resource limitations commonly faced by small and medium-sized enterprises (SMEs).

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