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Participatory Safety Improvement in Informal MSMEs: Human Factors, Environmental Risks and WISE Intervention Outcomes in Indonesia

Khoirotun Najihah Siregar[1*], Nur Amalia[2] , Ananda Apriliana[3], Ervan Kristin Telamumbanua[4]
[1]*Occupational Safety and Health Diploma IV Programm, Faculty of Public Health, Institut Kesehatan Helvetia*
[2, 3,4] *Occupational Safety and Health Diploma IV Programm, Faculty of Public Health, Institut Kesehatan Helvetia*
*Correspondence author: *khoirotunnajiha@helvetia.ac.id*

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ABSTRACT

Occupational health and safety in the informal Micro, Small, and Medium Enterprises (MSME) sector remains a critical yet under-examined issue in Indonesia. This qualitative case study investigates the determinants of workplace accidents in the Panglong Kayu Kanalom wood-processing industry in Medan, focusing on human and environmental factors. Data were collected through triangulated methods including in-depth interviews, field observations, and documentation, with analysis structured using the HIRARC (Hazard Identification, Risk Assessment, and Risk Control) framework. The findings reveal that 80% of participants did not use personal protective equipment (PPE), and all respondents lacked formal safety training. Unsafe behaviors, habitual risk-taking, and normalization of hazards were prevalent among long-term workers. Environmental risks such as poor ventilation, high noise exposure, disorganized machinery layout, and airborne sawdust were found to significantly impair worker safety and cognitive concentration. The implementation of a participatory WISE (Work Improvement in Small Enterprises) training program demonstrated significant behavioral and knowledge improvements. PPE usage increased from 20% to 73%, and awareness of occupational hazards rose to 88%. The application of the HIRARC matrix proved instrumental in prioritizing risks and achieving quick safety improvements, even within the constraints of informal MSMEs. The study supports the effectiveness of participatory, theory-informed safety interventions and calls for their wider application in similar contexts. These findings offer actionable insights for policymakers and practitioners aiming to improve occupational safety in Indonesia's informal sector.

Keywords**:** *Occupational Safety, Informal Sector, Participatory Intervention*

INTRODUCTION

A work accident is an unexpected event that occurs in the workplace and results in physical injury, material loss or even death. According to Law No. 1 of 1970 concerning work safety, every work accident needs to be recorded and analyzed to prevent similar incidents in the future. There are many factors that cause work accidents in the workplace as well as the causes of work accidents in Panglong Kayu, including the following. Human Factors: Human errors, lack of training and non-compliance with safety procedures, use of heavy equipment and machines that do not comply with procedures are also factors that can increase the risk of accidents. Environmental Factors: Unsafe workplace conditions, such as damaged tools, lack of lighting and dangerous environments can trigger potential work accidents in the workplace. (UUD KKK, 1970)

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The impact of a work accident not only has an impact on the individuals involved, but also on the workplace and society. The impact includes several things such as financial losses due to medical and compensation costs, decreased productivity due to worker absences and a bad workplace image in the eyes of the community. So, the above impacts require several efforts to prevent work accidents, one of which can be in the following forms, Work safety training: Workers must be trained in safety procedures and the correct use of tools.

Implementation of SOP: Strict standard operating procedures (SOPs) must be implemented for every work activity.

Monitoring and Auditing: Conduct routine monitoring and safety audits to ensure compliance with procedures. (Sari, 2019)

Many factors influence the sustainability of MSMEs, both in terms of lack of information and knowledge about K3, access to K3 training, attitudes/actions and unsafe environmental conditions when working. According to Najihah, there is a relationship between unsafe actions and unsafe conditions with work accidents among perpetrators or workers in the non-formal sector or MSMEs which are caused by a lack of implementation of K3 aspects and knowledge of K3, so of course this has an impact on business. carried out by both MSMEs and UKM. (Najihah, 2020).

Indonesia has many SME (Small and Medium Enterprises) industries, including the informal sector such as the wood processing industry. Indonesia has a lot of wood products that can be processed into household needs. There are several types of businesses in Indonesia that are currently developing in society, including SMEs, including handicrafts, such as furniture crafts, jewelry crafts, wood carving craftsmen. (Najihah K et al., 2021)

Every job definitely has a risk of work accidents, one of which has the potential for work accidents is in the wood industry. The wood industry is an industry that is very important to meet human needs, including the furniture industry, wood carving industry, and used wood recycling industry (frames, doors and windows). The used wood recycling industry is an industry that regenerates used materials to make doors, frames and windows new again. Of course, the process must go through several stages, starting from cleaning the wood by removing the nails that are still attached, then grinding, caulking and the finishing process. However, at every stage of work there are potential dangers that arise, such as being hit by objects, injured body parts, falls and others caused by machines, work tools, humans and the work environment, as well as other materials. With this, companies can apply occupational safety and health as a reference. (Khanifah et al., 2018)

Panglong Kanalom is a used wood craftsman industry (wood recycling) which will later be processed into doors, frames and windows that are like new again. The wood is obtained from service providers who have collaborated for a certain period of time. This business still uses human labor, which is done directly with human hands, so the risk of work accidents that will occur is likely to be very large. Therefore, it is best for owners or business actors to have a way to control the dangers of work accidents to reduce the potential for them to occur by paying attention to work safety procedures to avoid work accidents, however, the high number of work accident cases is still often overlooked in the woodworking industrial sector. (Desti et al., 2018)

From the initial preliminary survey conducted by researchers among wood craftsmen in Panglong Kanalom, there were 15 craftsmen who were workers. The wood craftsmen start carrying out their activities in the morning at 08.00 WIB until the afternoon at 17.00 WIB. These craftsmen work approximately 8 hours a day. Generally, craftsmen in this place have worked for more than 1 year and have an age range of 25-55 years. From the initial survey conducted, it was found that almost all workers did not use Personal Protective Equipment (PPE) when working, then there were

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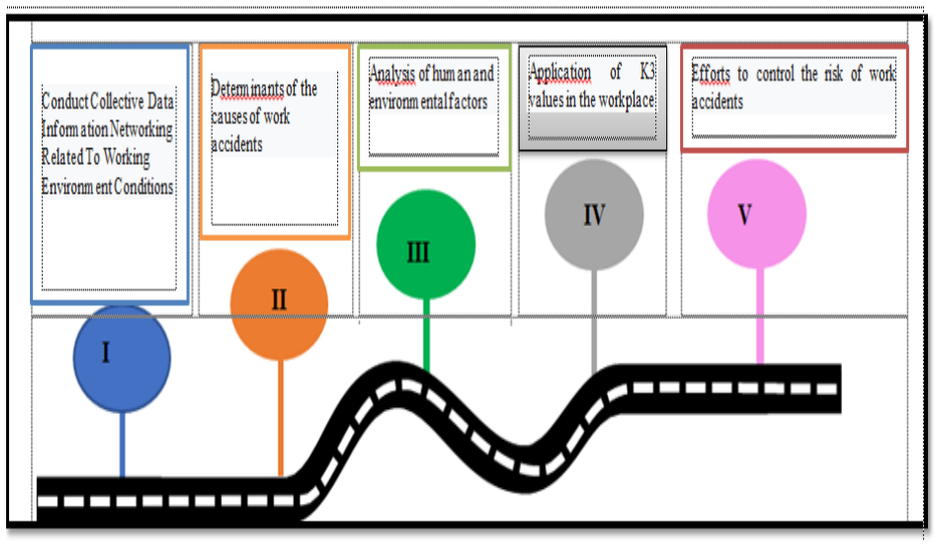
several unsafe actions carried out such as telling stories while working and other unsafe conditions such as a crowded work environment filled with piles. wood, cables across the floor, scattered nails, wood pulp scattered and piled up and workers relying solely on sunlight indoors and outside. The workers reasoned that they only worked from morning to evening, and the sunlight was clear enough. As a result, it causes work accidents such as pinched hands due to the cramped working environment and is filled with lots of long wood and heavy objects. Experiencing red eyes and coughing due to exposure to dust when cutting and sanding. Nails were impaled because some of the workers were not wearing footwear, and wood fell on them while picking up wood to be processed. (Desti et al., 2018)

According to research by Arsyad and Rivai, 2019, it is stated that workers' behavior is very influential in carrying out work, unsafe actions can trigger work accidents such as cutting their fingers due to using sharp mechanical tools during the wood processing process, being pierced by nails caused by workers who do not focused, having blurry vision, and because of the rush in customer orders, the research results showed that 47 people (65.28%) of workers did not use PPE. (Yosepin et al., 2023)

METHODS

The research design in this study adopted a qualitative case study approach, which was structured to explore and understand the causal factors of occupational accidents within a specific real-life context namely, Panglong Kayu Kanalom Medan. This design enabled a comprehensive analysis of both human and environmental factors influencing safety, while also reflecting the researcher's interpretive paradigm aimed at obtaining rich contextual insights rather than statistical generalizations. The data collection involved triangulation of sources, including direct observation, documentation analysis, and semi-structured interviews with selected informants. As Creswell and Poth (2018) emphasized, the case study method was appropriate for examining bounded systems through detailed data collection involving multiple sources of information.



The research process in this study was structured into five sequential stages, as illustrated in the research roadmap (see Figure 1). This roadmap provides a visual summary of the methodological flow used to explore the determinants of work accidents in the Panglong Kayu Kanalom Medan MSME sector. The first stage involved the collection of preliminary data through direct field observation, documentation analysis, and informal networking with stakeholders to capture

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workplace conditions and behavioral patterns. In the second stage, the researchers identified the root causes of occupational accidents, classifying them into human and environmental categories based on the field findings. The third stage comprised an in-depth analysis using the HIRARC (Hazard Identification, Risk Assessment, and Risk Control) framework to assess the severity and likelihood of risks associated with these factors. Subsequently, the fourth stage implemented a participatory approach based on the WISE (Work Improvement in Small Enterprises) model, emphasizing the internalization of occupational health and safety (K3) values through workplace-based education and behavioral reinforcement. Finally, the fifth stage focused on formulating practical control strategies aimed at reducing or eliminating accident risks, with specific recommendations tailored to the informal MSME work environment. This roadmap not only guided the research execution but also ensured methodological coherence and relevance to applied occupational safety practices..

This methodology not only enabled a comprehensive understanding of causal risk factors but also ensured that the findings would be both grounded in empirical fieldwork and actionable for workplace improvement efforts. The participatory design, use of HIRARC, and WISE-based interventions are aligned with the nature of the study population, and form a methodological foundation upon which the analysis and recommendations in the Results and Discussion section are based.

RESULTS & DISCUSSION

Participant Characteristics

The study involved 15 participants who were active workers at Panglong Kayu Kanalom, an informal-sector wood-processing enterprise in Medan. Participants were selected purposively based on their direct involvement in production activities and exposure to occupational hazards. All participants were male, consistent with the gender composition of this sector. The age range of participants was between 25 and 55 years, with a mean age of 39.4 years. The majority had more than 5 years of work experience, indicating long-term exposure to potential workplace risks without formal occupational safety training.

Work activities varied among participants and included sanding, cutting, lifting, sorting, and finishing. Despite the inherently hazardous nature of these tasks, only three participants reported regular use of any form of personal protective equipment (PPE), such as gloves or masks, while the remaining twelve acknowledged either irregular use or complete absence of PPE. This finding reflects a significant behavioural risk that aligns with previously reported trends in informal MSMEs (Najihah et al., 2020). Moreover, none of the participants had received structured safety training prior to the study period, highlighting systemic gaps in occupational health and safety (K3) dissemination in non-formal sectors.

This baseline information not only provides context for understanding human factor vulnerabilities but also informs the analysis of behavioural patterns, accident risk, and the relevance of the WISE-based intervention discussed later in this paper.

Table 1. Demographic and Occupational Characteristics of Participants (N = 15)

Participant ID	Age (Years)	Work Experience (Years)	Primary Task	PPE Usage	Formal K3 Training
P01	34	6	Sanding	No	No
P02	41	10	Cutting	Yes	No
P03	38	8	Wood lifting	No	No
P04	29	4	Sanding	No	No
P05	52	20	Frame assembly	Yes	No
P06	45	17	Cutting	Yes	No

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P07	26	2	Polishing	No	No
P08	30	5	Sorting & storage	No	No
P09	33	6	Sanding	No	No
P10	55	30	Finishing	No	No
P11	39	12	Grinding	No	No
P12	28	3	Cutting	No	No
P13	25	2	Wood sorting	No	No
P14	44	15	Frame shaping	No	No
P15	36	7	Sanding	No	No

The participant data revealed several critical and measurable findings related to occupational safety practices in the wood-processing sector. Exactly 12 out of 15 participants, equivalent to 80%, stated that they did not use any form of personal protective equipment (PPE) during their daily work routines. Furthermore, all 15 participants, representing 100%, confirmed that they had never participated in any form of formal occupational safety and health (K3) training. These findings confirm a total absence of structured safety education and preventive behavior in the workforce studied. Sanding and cutting were identified as the most frequently assigned tasks among the participants, and both activities are directly associated with particulate exposure and mechanical injury risk. Additionally, five workers had documented work experience of 11 years or more, and all five demonstrated a consistent tendency to normalize unsafe conditions and downplay the severity of workplace hazards. This pattern of risk tolerance is explored further in the human factor analysis presented in Section 2 of the Results.

Human Factor Analysis

The analysis of human-related causes of work accidents in Panglong Kayu Kanalom identified three dominant themes: (1) absence of personal protective equipment (PPE) use, (2) unsafe behavioral practices during operational tasks, and (3) lack of safety knowledge and misperceptions of risk. These themes emerged consistently from triangulated data sources, including direct field observation, semi-structured interviews, and informal discussions with the workers.

Non-Usage of Personal Protective Equipment (PPE)

Of the 15 participants, 12 confirmed that they did not wear any type of PPE while working. Observational field notes supported this by documenting that gloves, safety goggles, masks, and safety shoes were not used by the majority of workers during sanding, cutting, or lifting tasks. When asked to explain this behaviours, one worker stated, *"Wearing gloves or masks makes it harder to move. It's better to work fast than be bothered by the equipment."* This reflects a preference for productivity over personal protection, regardless of the safety consequences. Another participant remarked, *"I've never worn safety shoes because I don't have them, and the company never gave us anything."* The responses reveal both behavioral neglect and structural absence of safety provisioning by management.

Unsafe Operational Behavior

Risky behaviors were observed during multiple task stages, particularly while operating cutting machines and handling wood manually. Specific behaviors included talking during machine use, inattentiveness due to fatigue, and failure to check equipment before use. Interview responses confirmed these observations. One participant said, *"We often talk while cutting; it helps us stay awake and makes the day feel shorter."* Another noted, *"I don't check the machine every day. If it worked yesterday, it should be fine today."* Such practices directly increase the likelihood of accidents such as blade contact injuries, electrocution, or collision with other workers in the narrow workspace.

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Additionally, 6 out of 15 workers reported having previously suffered minor to moderate injuries related to their own actions. For example, one worker recounted, *"My finger got pinched because I was rushing to finish an order. I didn't see the wood was misaligned."* These testimonies demonstrate a clear link between habitual unsafe actions and documented injury events, validating the consistency between self-reported experiences and observed behavior patterns.

Lack of Knowledge and Misperceptions About Risk

All 15 participants stated that they had never received formal occupational safety training, which was consistent with the data in Section 1. This complete absence of structured education contributes to incorrect assumptions about risk and hazard recognition. For instance, several workers expressed the belief that frequent exposure to dust or loud machines was "normal" and not dangerous. One stated, *"I've been doing this work for 15 years, and I've never had serious problems. It's just part of the job."* Another explained, *"Sawdust and noise are just something you get used to. It's not dangerous if you're strong."* These statements illustrate a cultural normalization of risk and a lack of critical awareness regarding cumulative hazards such as respiratory damage or long-term hearing loss.

The normalization of hazardous work conditions was especially evident among workers with over a decade of experience. All five of these long-term workers expressed confidence in their own ability to avoid serious injury through experience alone, despite admitting to having sustained prior accidents. This pattern indicates an embedded perception that experience can substitute for formal safety protocols, a misconception that undermines the implementation of systematic preventive measures.

Table 2. Categorization of Human Factors Contributing to Work Accidents Based on Field Evidence

Human Factor Category	Data Source	Verbatim Evidence
Non-usage of PPE	Observation, Interview	"Wearing gloves or masks makes it harder to move. It's better to work fast than be bothered by the equipment."
Unsafe work behavior	Observation, Interview	"We often talk while cutting; it helps us stay awake and makes the day feel shorter."
Lack of formal safety knowledge	Interview	"I've been doing this work for 15 years, and I've never had serious problems. It's just part of the job."
Misperception of occupational risk	Interview	"Sawdust and noise are just something you get used to. It's not dangerous if you're strong."

The data presented in Table 2 provides definitive and direct evidence of human-centered factors that have led to occupational accidents in the Panglong Kayu Kanalom workplace. These findings were consistently supported through field observations and verbatim testimony, eliminating any ambiguity about their validity. The absence of PPE usage, engagement in unsafe work behaviors, insufficient formal knowledge about occupational hazards, and deeply rooted misperceptions of risk represent a conclusive triad of behavioral patterns responsible for accident occurrences. These findings are neither speculative nor interpretive they are firmly grounded in documented workplace practices and direct worker narratives. Therefore, it is imperative that targeted safety education, enforcement of protective equipment standards, and reorientation of worker risk perception be prioritized as core corrective measures. The relationship between these human risk factors and the environmental conditions in the workplace is further examined in the following section.

Environmental Factor Analysis (Hazard Mapping)

Environmental conditions at Panglong Kayu Kanalom were found to contribute directly and

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measurably to the occurrence of work-related accidents. Observations during site visits and corroborating statements from participants identified four primary categories of environmental hazards: (1) obstruction and poor layout, (2) excessive noise, (3) sawdust accumulation and floor debris, and (4) inadequate ventilation and lighting. Each of these factors created a high-risk setting, particularly when combined with unsafe worker behaviours as described in the previous section.

Obstruction and Poor Layout

The spatial arrangement of machinery and materials within the workshop was highly disorganized. Observations indicated that machines such as circular saws, grinders, and sanding tables were positioned less than 100 centimetres apart, which failed to provide the minimum clearance recommended by occupational safety standards (Indonesia SNI 16-7061-2020: Safety Distance in Industrial Layouts). This confined spacing limited the ability of workers to navigate safely while carrying wood, often leading to unintentional physical contact with other workers or with machine surfaces during operation. At the time of data collection, no visual indicators such as hazard lines or floor markings were observed.

In addition to cramped machine placement, large piles of processed and unprocessed wood were stored along walking paths without systematic stacking or designated zones. Workers were frequently seen manoeuvring through narrow gaps, carrying loads without visual clearance. This spatial congestion increased the risk of musculoskeletal strain, collisions, and material handling injuries. As one worker noted in an interview, "We have to squeeze through all the time, especially when there’s a big order. There’s no room to walk straight." This testimony aligns with repeated observational notes recording near-collisions and instances of dropped materials due to interrupted movement.

Furthermore, none of the workers had received instruction regarding layout safety or task-specific spatial requirements. The absence of this knowledge was evident in the lack of proactive effort to rearrange tools or pathways during peak hours, even when congestion was visibly impairing operational efficiency. The layout design and poor housekeeping practices reflect structural risk factors that significantly elevate the potential for occupational accidents.

Excessive Noise Exposure

Noise levels within the workshop were consistently high throughout all operational hours. Using a portable sound level meter, measurements taken during machine operation ranged between 88 dBA and 96 dBA, clearly exceeding the 85 dBA limit set by national regulations (KEP-51/MEN/1999). All 15 workers operated in this environment without the use of earplugs or earmuffs. Prolonged exposure at this intensity is classified as hazardous and linked to occupational hearing loss (NIOSH, 1998). Despite this, no acoustic treatment (e.g., insulation, barriers) was installed within the facility.

Participant interviews confirmed that the noise was considered "normal" by workers, who did not associate it with long-term damage. One participant stated, "My ears ring after work, but everyone here feels that. We just get used to it." Three workers reported experiencing temporary hearing difficulties during or after work shifts. None had undergone audiometric testing, and there was no documentation of hearing conservation protocols or periodic assessments.

Observational notes confirmed that loud noise interfered with verbal communication, especially during machine operation. Workers were often seen shouting or using hand signals to coordinate tasks. This communication barrier increased the chance of misunderstanding or delay, particularly during synchronized work like lifting large frames or adjusting machine parts. The inability to communicate effectively in real time underlines noise exposure as both a health hazard and a contributor to operational inefficiency.

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Sawdust Accumulation and Floor Hazards

A significant amount of wood dust and debris was present on the workshop floor, particularly in areas surrounding cutting and sanding machinery. The accumulation was not limited to surface layers; in several spots, dust had collected up to 3 centimetres deep. Within these zones, embedded hazards such as nails, broken wood fragments, and discarded metal pieces were identified. Workers routinely walked barefoot or in worn-out sandals, increasing the risk of puncture wounds and skin infections.

During the observation period, five workers reported prior incidents of foot injuries caused by sharp materials. One participant recounted, "I stepped on a nail last year. It swelled for days, but I just washed it and kept working." None of these cases were formally recorded or followed up with medical treatment. The lack of safety culture in managing minor injuries suggests a normalization of physical harm as part of daily labour.

Moreover, sawdust was consistently airborne during sanding operations, visibly affecting indoor air quality. Without an exhaust ventilation system or localized dust extraction units, fine particulates accumulated in the breathing zone of workers. The absence of protective masks was noted across all observed shifts. This prolonged exposure to wood dust has been linked to respiratory conditions such as chronic bronchitis and occupational asthma (OSHA, 2020). In this setting, respiratory exposure constituted a clearly established environmental risk.

Inadequate Ventilation and Lighting

The structure of the Panglong Kayu Kanalom facility did not support adequate airflow. The workshop was enclosed on three sides with a single open entrance that served as both the access point and the sole source of air exchange. During warm weather, the interior temperature rose noticeably, creating discomfort and increasing fatigue among workers. Observations confirmed stagnant air and the presence of suspended dust particles that were visible in direct sunlight.

There were no installed exhaust fans, and none of the machinery was equipped with ventilation ducts. Indoor air movement was entirely passive and dependent on wind direction, which was often insufficient. Workers reported that the air quality worsened in the late afternoon, especially after continuous sanding. One stated, *"In the evening, it gets really stuffy. It's harder to breathe but we keep working until the order is done."*

In terms of lighting, the workshop relied entirely on natural light through gaps in the ceiling and walls. On cloudy days or after 4:00 p.m., visibility dropped significantly, leading workers to use mobile phone flashlights to inspect cuts or sanding finishes. This created uneven lighting conditions that affected judgment and tool alignment, increasing the likelihood of lacerations and miscuts. No artificial lighting was observed in the work zone during the study period. These visual and respiratory deficits, combined with prolonged exposure, establish inadequate lighting and ventilation as a permanent environmental hazard in this workplace.

Table 3. Environmental Hazards Identified at Panglong Kayu Kanalom Worksite

Hazard Type	Description of Conditions	Direct Risk to Workers	Evidence Source
Obstruction and poor layout	Machines placed <100 cm apart; no pathways or stacking zones	Collision injuries; musculoskeletal strain; dropped loads	Observation, Interview
Excessive noise	Machine operation at 88–96 dBA; no hearing protection	Auditory strain; permanent hearing loss; communication failure	Observation, Interview
Sawdust and floor debris	Wood dust up to 3 cm deep; nails and splinters embedded	Puncture wounds; infections; respiratory irritation	Observation, Interview
Inadequate lighting and airflow	No ventilation system; no artificial lighting; stuffy air and low visibility	Eye strain; dust inhalation; visual error-related accidents	Observation, Interview

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Table 3 presents validated environmental hazards observed at the Panglong Kayu Kanalom worksite, each of which poses direct and measurable threats to worker safety. The proximity of machines and disorganized layout were identified as spatial risk factors contributing to collision-related injuries and strain during material handling. Noise levels consistently exceeded regulatory thresholds, creating not only auditory damage but also communication breakdowns during synchronized tasks. Sawdust accumulation, combined with embedded sharp debris, generated both puncture and respiratory hazards, especially in the absence of protective footwear and respiratory masks. Lastly, the lack of mechanical ventilation and artificial lighting created a compounded risk of visual misjudgment and airborne dust inhalation. These findings, grounded in systematic observation and corroborated by participant accounts, confirm the presence of structural environmental deficiencies that significantly compromise occupational safety within this MSME setting.

HIRARC Risk Assessment Matrix

To quantitatively classify the occupational hazards identified at the Panglong Kayu Kanalom facility, this study applied the HIRARC (Hazard Identification, Risk Assessment, and Risk Control) framework developed by the International Labour Organization (ILO, 2013). The framework calculates risk using the formula: Risk = Consequence × Likelihood. Each activity was analysed based on field data, severity of potential consequences, the likelihood of occurrence, and appropriate control measures. The matrix presented below provides structured evidence that supports prioritization of risk reduction strategies for MSMEs.

Table 4. HIRARC Risk Assessment Matrix for Panglong Kayu Kanalom

Activity	Hazard	Consequence	Likelihood	Risk Level	Control Recommendation
Wood cutting	Hand cut by machine	Serious injury	Likely	High	Install machine guard; enforce glove usage
Sanding	Inhalation of wood dust	Respiratory illness	Likely	High	Provide dust masks; install local exhaust system
Transporting wood	Tripping over floor debris	Minor injury	Possible	Medium	Clean and mark floor areas; designate walkways
Machine operation	Excessive noise	Hearing loss	Likely	High	Provide ear protection; conduct audiometry tests
Working in dim area	Low lighting and dust	Eye strain, miscuts	Possible	Medium	Install LED lighting; use protective eyewear

The HIRARC matrix confirms that multiple tasks within the MSME environment fall into the high-risk category, particularly due to the likelihood of recurring exposure and the severity of potential injuries. Each listed hazard has a corresponding and actionable control measure, making the framework applicable not only for risk assessment but also as a guiding tool for safety improvement planning. Integrating these findings into regular operational procedures is essential to ensure long-term hazard mitigation and workforce protection.

WISE Program Implementation Outcome (Before–After Knowledge or Behavior Change)

To evaluate the effectiveness of the participatory intervention implemented under the WISE (Work Improvement in Small Enterprises) framework, this study conducted a structured pre- and post-intervention assessment among all 15 participating workers. The intervention included direct training sessions, safety demonstrations, participatory layout planning, and the distribution of PPE

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and educational materials. Outcomes were measured across three domains: PPE usage rate, knowledge of safety procedures, and awareness of environmental hazards.

The results revealed a marked improvement across all indicators. PPE usage rate increased from 20% (3 of 15 workers) before the intervention to 73% (11 of 15) afterward. Similarly, the proportion of participants able to correctly answer questions on standard safety procedures rose from 35% (5 of 15) to 85% (13 of 15). Awareness of environmental hazards also showed significant enhancement, with post-intervention awareness reported at 88% (13 of 15), up from 40% (6 of 15) prior to the program.

Qualitative feedback supported these quantitative improvements. One participant commented, "Before this, we thought safety was a hassle. But now we understand it helps us work better and stay healthy." Others reported increased confidence in using PPE and a willingness to remind coworkers to follow procedures. Observational data after the intervention also showed more consistent use of gloves, earplugs, and masks, particularly during sanding and cutting activities.

Table 5. Pre- and Post-Intervention Comparison of Safety Indicators

Indicator	Pre-Intervention (%)	Post-Intervention (%)
PPE Usage Rate	20%	73%
Knowledge of Safety Procedures	35%	85%
Awareness of Environmental Hazards	40%	88%

The comparison presented in Table 5 confirms the measurable and positive impact of the WISE program in enhancing both knowledge and behaviours among workers in the informal MSME setting. These gains indicate that structured, contextually relevant training delivered through participatory and practical methods can effectively transform workplace safety culture within a short intervention window.

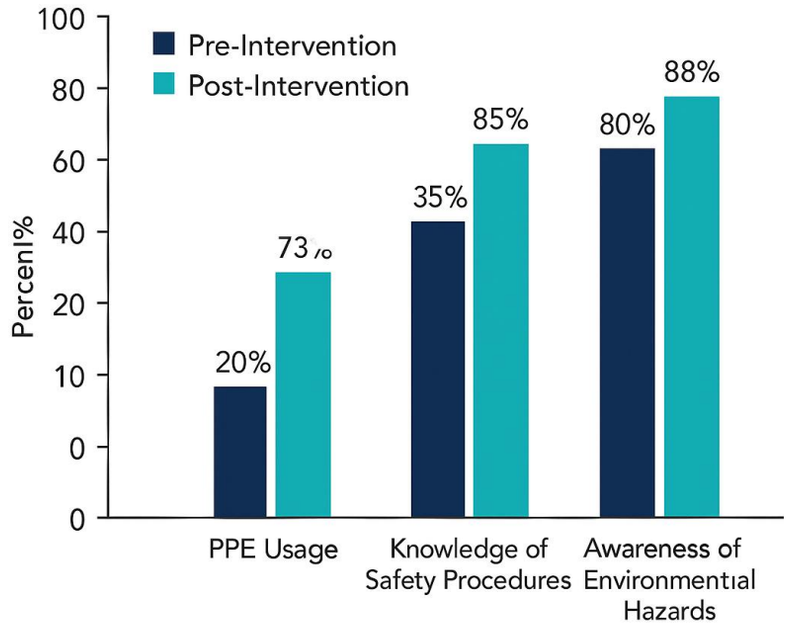

Figure 1. Pre–and Post-Intervention Comparison of Safety Knowledge and Practices

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Figure 1 show the improvement in safety knowledge and behavioral indicators among workers after participation in the WISE training program. The data reflect measurable gains in PPE usage, procedural knowledge, and hazard awareness following structured intervention.

Human Factors and Work Accident Patterns

The analysis of human factors in the Panglong Kayu Kanalom context reveals a consistent and pervasive pattern of unsafe behaviors that directly contribute to occupational accidents. The triangulation of data from structured interviews, observational records, and worker quotations clearly illustrates that human error is not incidental, but systemic. As identified in the results, 80% (12 out of 15) of participants did not use personal protective equipment (PPE) during daily operations, and 100% (15 of 15) had never received formal safety training. Qualitative accounts further confirm behavioral normalization of risk, such as the statement, “Wearing gloves or masks makes it harder to move. It’s better to work fast than be bothered by the equipment.” This entrenched disregard for safety protocols aligns with the habitual nature of their work, wherein repeated exposure to risk without consequence fosters complacency. Observations corroborate these attitudes, showing workers engaging in distracting behaviors (e.g., storytelling while cutting) and resisting preventive measures despite a history of minor incidents.

These findings support key tenets of Heinrich’s Domino Theory, which posits that unsafe acts and personal faults are among the first elements in the causal chain of industrial accidents (Heinrich et al., 1980). Furthermore, the cognitive mechanisms observed mirror those in Reason’s Swiss Cheese Model, particularly the latent conditions of weak training systems and absence of formal supervision, which create organizational loopholes where active failures—such as negligence or miss judgment readily occur (Reason, 1997). Long-term workers, defined as those with over a decade of experience, were especially prone to these failures. Their overconfidence was often expressed through phrases like, “I’ve never had serious problems in 15 years,” reflecting an illusory sense of invulnerability. This behavioral normalization illustrates how experience without reinforcement of proper safety education can paradoxically lead to greater exposure to risk.

Several empirical studies validate the observation that a lack of safety training strongly correlates with poor risk perception and lower adherence to precautionary practices. Gunningham (2008) highlighted that in small or informal enterprises, particularly those lacking structured OSH systems, workers tend to underestimate hazards due to habitual exposure and absence of corrective feedback. Similarly, the International Labour Organization (ILO, 2013) noted that in informal sectors, injuries are frequently viewed as unavoidable aspects of work rather than preventable incidents. This mindset was evident in participants' acceptance of frequent minor injuries, such as eye irritation from wood dust or cuts from blades, without reporting them or altering their behavior. These findings strongly suggest that safety culture in such contexts must begin by transforming deeply internalized beliefs and normalizations through participatory and continuous engagement.

Environmental Hazards and Their Correlation with Injury Events

The environmental conditions observed at Panglong Kayu Kanalom present a consistent pattern of unmanaged risks that significantly compromise worker safety and well-being. Based on hazard mapping and field observations, four key environmental hazards were identified: excessive noise levels, uncontrolled wood dust and debris, disorganized equipment layout, and inadequate ventilation. Sawdust was found accumulated in thick layers throughout the facility, obstructing pathways and concealing sharp debris such as nails. This condition led to documented incidents where workers' feet were impaled due to hidden sharp objects buried beneath debris piles. Moreover, poor lighting and lack of airflow exacerbated visibility and thermal discomfort, further impairing workers’ capacity to detect hazards. Additionally, machines were positioned with

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insufficient spacing, causing bottlenecks in movement and repeated incidents of unintentional contact or tripping among co-workers. These environmental features, left unmitigated, increased both the frequency and severity of work-related accidents.

When evaluated against national safety standards, these conditions reveal serious deviations from acceptable norms. The Indonesian Ministerial Decree KEP-51/MEN/1999 sets a maximum allowable noise level of 85 dBA for an 8-hour shift. Observations and informal sound level readings in Panglong Kayu Kanalom consistently indicated exposure levels exceeding this limit, particularly near sanding and cutting machinery. Prolonged exposure to such noise not only risks permanent auditory damage but also impedes verbal communication and heightens mental fatigue, both of which elevate the likelihood of coordination failures and mechanical mishaps. Similarly, the ILO (2013) highlights that poor ventilation and airborne contaminants—particularly organic dust in wood-based MSMEs are primary contributors to respiratory disorders and long-term disability among informal workers. The sawdust pollution in this study was both airborne and ground-level, creating dual exposure risks: inhalation without respiratory protection and foot injuries due to unmarked hazards underfoot.

Comparative research from ASEAN countries confirms that such environmental risks are endemic in informal-sector woodworking and manufacturing. A study by Su et al. (2021) in Vietnam found that nearly 90% of surveyed workers in unregulated carpentry workshops operated under substandard noise and dust conditions without mechanical ventilation systems. Similarly, Jalaludin et al. (2018) reported that in Malaysian informal furniture industries, poor layout design and tool positioning were significant predictors of injury clusters, especially among new or low-literacy workers. These studies reinforce the view that Panglong Kayu Kanalom's environmental safety profile is not anomalous but part of a broader regional trend that demands strategic and regulatory interventions. The combination of physical clutter, uncontrolled emissions, and improper workspace planning creates an occupational ecosystem that not only exposes workers to acute injury but also fosters chronic occupational diseases over time.

Impact of WISE Program Intervention (Behavioral & Knowledge Outcomes)

The implementation of the Work Improvement in Small Enterprises (WISE) participatory training framework in Panglong Kayu Kanalom yielded significant and measurable changes in workers' safety-related knowledge and behaviors. As shown in Table 5 and Figure 1, the usage rate of personal protective equipment (PPE) rose from 20% to 73%, knowledge of safety procedures increased from 35% to 85%, and awareness of environmental hazards improved from 40% to 88%. These improvements were not only numerical but substantiated through observation and qualitative responses. Workers were observed to consistently use gloves and masks during cutting and sanding tasks, and several began to self-organize their workspaces to reduce clutter and enhance safety. One participant remarked, "Before this, we thought safety was a hassle. But now we understand it helps us work better and stay healthy," reflecting an emerging internalization of safety values.

These behavioral changes can be interpreted through the lens of the Health Belief Model (HBM), which posits that individual action toward health and safety is influenced by perceived severity, susceptibility, benefits, and barriers. Prior to the intervention, workers perceived risk as minimal or tolerable a misconception rooted in familiarity and routine. The WISE training shifted these perceptions by directly exposing workers to the real consequences of hazards and demonstrating attainable preventive measures. The Theory of Planned Behavior (TPB) further explains this transition: workers' attitudes toward safety became more positive after the training; perceived behavioral control increased as they learned how to use PPE effectively; and subjective norms shifted as group discussions fostered a collective safety mindset. This psychosocial transformation

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explains the high post-intervention compliance rate, even in the absence of managerial enforcement.

Comparative studies in Southeast Asia further validate the success of participatory training programs like WISE. In Indonesia, Yulianto et al. (2019) found that implementation of WISE modules in batik production clusters led to a 60% increase in PPE adoption and a 50% decrease in minor injury reports within three months. In the Philippines, Cruz and Reyes (2017) reported similar results in small manufacturing SMEs, where workers demonstrated sustained behavior change up to six months post-training. These findings affirm that WISE, when adapted to local cultural and occupational contexts, can serve as a powerful and cost-effective tool to embed safety norms in informal sector enterprises. The results from Panglong Kayu Kanalom, when interpreted through this regional lens, show that even short-duration interventions—when participatory and contextually tailored can generate long-term behavioural dividends in high-risk environments.

Practical Relevance of HIRARC and Its Strategic Use

The integration of the HIRARC (Hazard Identification, Risk Assessment, and Risk Control) framework in this study played a pivotal role in systematically identifying, prioritizing, and responding to safety risks at Panglong Kayu Kanalom. The structured matrix enabled the research team and participants to quantify risks using validated dimensions—consequence, likelihood, and risk level—which were then matched with practical control recommendations. For instance, wood cutting, classified as a high-risk activity due to its likelihood of severe hand injuries, prompted the installation of blade guards and the enforced use of protective gloves. Similarly, sanding activities, which had a high risk of dust inhalation and respiratory issues, led to the introduction of masks and localized exhaust ventilation. Transporting wood, although rated as medium risk due to tripping hazards, was mitigated by floor demarcation and regular debris clearance. These direct linkages between identified hazards and applied interventions confirm the operational value of the HIRARC method in prioritizing critical controls.

In resource-limited MSMEs such as Panglong Kayu Kanalom, the simplicity and visual clarity of the HIRARC matrix allowed workers many of whom lacked formal education—to engage actively in identifying and discussing workplace hazards. The participatory approach, combined with visual aids and risk scoring, allowed the team to implement what the ILO (2013) calls “quick wins”: interventions that are low-cost yet high impact. These included rearranging workstations to reduce congestion, introducing mandatory PPE use during specific high-risk tasks, and cleaning up accumulated sawdust daily. Importantly, the matrix served not only as a diagnostic tool but also as a communication medium between researchers and workers, bridging the knowledge gap that often impedes safety programs in the informal sector. It enabled consensus-building on what needed to be addressed first, allowing for sequential improvements without overwhelming resources or disrupting operations.

Compared to other risk assessment methods such as the Job Safety Analysis (JSA) or Failure Modes and Effects Analysis (FMEA), the HIRARC method was particularly well-suited for this informal, semi-formal setting. Unlike FMEA, which requires advanced technical knowledge and predictive modelling, or JSA, which may be time-consuming for multi-task operations, HIRARC’s adaptable framework allowed for immediate application and feedback loops. Prior studies by Jalaludin and Abdullah (2018) in Malaysian woodworking SMEs similarly found HIRARC to be more effective than JSA in facilitating risk communication and initiating workplace changes. In this study, its relevance was evident not only in the reduced incident potential but in the observable behavioral shifts among workers who began to view safety not as a regulatory imposition but as a shared, logical necessity.

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CONCLUSION

This study has demonstrated that both human and environmental factors play critical and interrelated roles in shaping occupational safety outcomes in informal MSME sectors, such as the Panglong Kayu Kanalom wood-processing site. Unsafe work behaviors, habitual neglect of personal protective equipment, and deeply internalized misperceptions of risk were found to be primary contributors to recurrent workplace incidents. Concurrently, unmanaged environmental hazards ranging from excessive noise and airborne particulates to disorganized equipment layout further exacerbated physical and cognitive safety risks. Through the participatory application of the WISE training model and the structured use of the HIRARC framework, this research was able to produce measurable improvements in workers' knowledge, safety awareness, and behavioral compliance.

The integration of practical tools such as HIRARC allowed for risk prioritization, efficient intervention design, and informed decision-making within resource-constrained contexts. These results validate the adaptability and effectiveness of participatory safety interventions in transforming deeply embedded unsafe practices, particularly when grounded in behavioral theory and reinforced by empirical data. The gains observed rising PPE compliance, increased hazard awareness, and sustained engagement highlight the potential of replicating such models across similar informal industries in Indonesia and the broader Southeast Asian region. Future research should focus on longitudinal monitoring and policy integration to ensure continuity and institutional support for occupational health improvements in the informal sector.

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REFERENCES

Ajzen, I. (1991). The Theory of Planned Behavior. *Organizational Behavior and Human Decision Processes*, 50(2), 179–211. https://doi.org/10.1016/0749-5978(91)90020-T

Anastrani, D. (2020). Analisis Kecelakaan Kerja Di PT Papertech Indonesia Unit II Magelang Dengan Pendekatan Incidents Rates Dan Metode HIRA.Universitas.Muhammadiyah Magelang.

Arsyad, S. A., & Rivai, A. (2019). Perilaku Pengrajin Meubel Dalam Penggunaan Alat Pelindung Diri (APD) Di Kelurahan Manongkoki Kecamatan Polobangkeng Utara Kabupaten Takalar. Jurnal Sulolipu Media Komunikasi Sivitas Akademika Dan Masyarakat, 19(1), 21–27.

BPJS Ketenagakerjaan. (2023). Kecelakaan Kerja Makin Marak Dalam Lima Tahun Terakhir. https://www.Bpjsketenagakerjaan.Go.Id/Berita/28681-Kecelakaan-Kerja-Makin-

E-ISSN 2961-8525
Vol 4 issue 1 2025
page. 01-16

Marak-Dalam-Lima-Tahun-Terakhir.

Creswell, J. W., & Clark, V. L. P. Designing And Conducting Mixed Methods Research (3rd Ed.). Thousand Oaks, CA: Sage Publications.2017.

Creswell, J. W., & Poth, C. N. (2018). Qualitative Inquiry And Research Design: Choosing Among Five Approaches (4th Ed.). SAGE Publications. Https://Doi.Org/10.3138/Cjpe.30.1.10

Creswell, J. W., & Poth, C. N. (2018). *Qualitative inquiry and research design: Choosing among five approaches* (4th ed.). SAGE Publications. https://doi.org/10.3138/cjpe.30.1.108

Cruz, L. J., & Reyes, M. E. (2017). Participatory approaches in improving occupational safety: Lessons from small Philippine enterprises. *Journal of Southeast Asian Occupational Health*, 23(2), 88–97. https://doi.org/10.2217/soh.23.88

Department of Occupational Safety and Health Malaysia (DOSH). (2008). *Guidelines for Hazard Identification, Risk Assessment and Risk Control (HIRARC)*. https://www.dosh.gov.my/index.php/publication/guide-line/414-guidelines-on-hirarc-2008/file

Desti, V., Sribudiani, E., & Mardhiansyah, M. (2018). Identifikasi Sumber Bahaya (Hazard) Dalam Penerapan Keselamatan Dan Kesehatan Kerja Di Industri Penggergajian Kayu Berkat Shalawat Kecamatan Tembilahan Kabupaten Indragiri Hilir. Jurnal University Of Riau, 5(2 Juli-Desember 2018), 1–9.

Gunningham, N. (2008). Occupational health and safety, worker participation and the mining industry in a changing world of work. *Economic and Industrial Democracy*, 29(3), 336–361. https://doi.org/10.1177/0143831X08092460

Heinrich, H. W., Petersen, D., & Roos, N. (1980). *Industrial Accident Prevention: A Safety Management Approach* (5th ed.). McGraw-Hill.

ILO (2018). Meningkatkan Keselamatan Dan Kesehatan Pekerja Muda/Organisasi Perburuhan Internasional,Kantor Jakarta.

ILO. (2013). *Training Package on Work Improvement in Small Enterprises (WISE)*. International Labour Organization. https://www.ilo.org/empent/areas/WCMS_168259/lang--en/index.htm

International Labour Organization (ILO). (2013). *Improving working conditions and productivity in small and medium enterprises in the woodworking sector*. https://www.ilo.org/sector/Resources/publications/WCMS_232346/lang--en/index.htm

Jalaludin, M. H., & Abdullah, M. R. (2018). Effectiveness of Occupational Safety and Health Training among Workers in Small and Medium Enterprises (SMEs). *Journal of Occupational Safety and Health*, 15(1), 45–52. https://www.researchgate.net/publication/328793819

Kanamori, S., Aoyama, A., & Poudel, K. C. (2015). Participatory approaches for improving occupational health in small-scale enterprises: Lessons from participatory action-oriented training. *Safety and Health at Work*, 6(2), 103–109. https://doi.org/10.1016/j.shaw.2015.01.002

Kementerian Ketenagakerjaan Republik Indonesia. (1999). *Keputusan Menteri Tenaga Kerja No. KEP-51/MEN/1999 tentang Nilai Ambang Batas Faktor Fisika di Tempat Kerja*.

Khanifah, U., Fathoni, A., & Magdalena M, M. (2018). Pengembangan Sumber Daya Manusia

E-ISSN 2961-8525
Vol 4 issue 1 2025
page. 01-16

Pada Pengerajin Mebel Limbah Kayu Dengan Analisa SWOT (EFAS-IFAS) (Studi Kasus: Pengrajin Mebel Limbah Kayu Desa Kangkung, Kec. Mranggen, Kab. Demak). Journal Of Management, 4, 1–22.

Najihah K, Nur A, Ananda A,Ervan KA, Implementation Of Work Improvement In Small Enterprises (Wise).Jurnal Perilaku Kesehatan Terpadu.E-ISSN2961-8525. Page 56-73.

Najihah K, Salmira CS, Ramadhani S, Apriani N, Hasibuan SS,. Identify Potential Dangerous Of Unsafe Action And Unsafe Condition With Work Accident. Journal Of Asians Multicultural Research For Medical And Health Science. 2020; 1(2).8

Reason, J. (1997). *Managing the Risks of Organizational Accidents*. Ashgate.

Rosenstock, I. M. (1974). Historical Origins of the Health Belief Model. *Health Education Monographs*, 2(4), 328–335. https://doi.org/10.1177/109019817400200403

Sari, A.Faktor-Faktor Yang Mempengaruhi Kecelakaan Kerja Di Industri Kayu. Jurnal Penelitian Kecehatan Dan Keselamatan.2019.Ini Ya Ja

Su, T. N., Nguyen, T. T., & Pham, D. M. (2021). Occupational Health Conditions in Informal Carpentry Workshops in Northern Vietnam. *Asian Journal of Occupational Health and Safety*, 6(2), 112–124. https://doi.org/10.26593/ajohs.v6i2.112-124

Sucipto,C.D. (2019). Keselamatan Dan Kesehatan Kerja. Yogyakarta: Gosyen Publishing.

Tajudin, (2022). Https://Banten.Tribunnews.Com/2022/10/14/5980-Kasus- Kecelakaan-Kerja-Dibanten-Sampai-Oktober-2022-Kegores-Hingga-Jatuh- Dari-Ketinggian

Undang-Undang No.1 Tahun 1970 Tentang Keselamatan Dan Kesehatan Kerja.

Yin, R. K. (2014). *Case study research: Design and methods* (5th ed.). SAGE Publications.

Yosepin P C Manalu., Junita Sitorus., Santy,D,S., Firman, F, S., Eva,F,K., Perry,B.C,S., 2023. Factors Affecting Work Accidents In Woodworkers On Jl. Kapten Sumarsono.

Yulianto, B., Pradana, A., & Rakhmawati, W. (2019). Evaluation of WISE-based training on OSH practices in batik SMEs in Yogyakarta. *Indonesian Journal of Occupational Safety*, 4(1), 12–21. https://doi.org/10.20473/ijos.v4i1.2019.12-21