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Case study article

Work hazards at workstations in the leather tanning industry using the Hazard Identification and Risk Assessment (HIRA) method

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ABSTRACT

In the Indonesian manufacturing industry, potential hazards and work-related risks are prevalent, often resulting from worker negligence or unforeseen incidents. To address these issues, companies must enhance risk management strategies based on occupational safety and health principles. This study aims to identify hazards and assess work-related risks at workstations in Department C of the leather tanning industry using primary and secondary data. Primary data were collected directly from the production floor, while secondary data were obtained from company records. The risk assessment classified hazards into four categories: Extreme (E), High (H), Moderate (M), and Low (L), based on severity and likelihood. The findings identified potential physical, chemical, and ergonomic hazards, with three high-risk activities, five medium-risk activities, and two low-risk activities. To mitigate these risks, control measures such as personal protective equipment (PPE), warning signs, Material Safety Data Sheets (MSDS), and strict adherence to company regulations should be implemented. These preventive actions are expected to reduce high- and medium-risk activities to lower risk levels, ultimately minimizing workplace accidents.

1. Introduction

In the Indonesian manufacturing industry, potential hazards and work-related risks remain frequent. Workers, for example, often interact directly with machines, tools, and work environments that are prone to accidents. The level of risk depends on the type of industry, technology used, and the effectiveness of process control measures implemented. These hazards and risks can result in both material and non-material losses, affecting companies, workers, and even surrounding communities. Occupational safety and health (OSH) is a key factor in mitigating these hazards. Workplace safety encompasses machines, equipment, materials, manufacturing processes, work environments, and work practices [1].

Occupational health, as a specialized field, focuses on preventing and treating health issues—both physical and mental—caused by job-related factors and general diseases [2]. OSH refers to a work environment free from physical and mental harm, ensuring that workers have the right to safety and health protections provided by their employers [3]. The Occupational Safety and Health Management System (OSHMS) is a comprehensive framework within organizations that includes organizational structure, planning, implementation, responsibilities, procedures, processes, and resources required to achieve workplace safety and health goals. OSHMS aims to mitigate risks and create a safe, comfortable, and productive work environment [4]. According to the International Labour Organization (ILO), more than 250 million workplace accidents occur annually, with over 160 million workers suffering from occupational illnesses. Additionally, 1.2 million workers lose their lives due to workplace accidents and diseases. These statistics highlight the significant human and economic costs associated with workplace hazards. In general, workplace accidents can occur due to two factors: human and environmental. Human factors arise from a lack of attention and actions that unintentionally violate regulations. Meanwhile, environmental factors involve unsafe conditions and non-standard levels of cleanliness [5].

This study was conducted in a company operating in the leather tanning industry. The company primarily

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uses aging machines in its production process, which can pose risks to operators. Workplace accidents refer to incidents occurring within a company that are related to work activities. These accidents are generally caused by unsafe human behavior that does not comply with safety standards, as well as hazardous environmental conditions [6]. Risk prevention measures include conducting routine occupational safety and health (OSH) reviews, ensuring the use of complete personal protective equipment (PPE), and strengthening management control over workers who fail to use PPE [7]. Workers are a company's most valuable resource, and their safety must be ensured to protect them from potential workplace accidents.

The primary objective of this research is to identify potential hazards and assess the risks and impacts associated with tanning process activities in Department C. Using the Hazard Identification and Risk Assessment (HIRA) method, this study aims to analyze specific hazards and risk levels to minimize workplace accidents in the leather tanning industry, particularly in Department C [8].

2. Material and method

In this study, the workplace under investigation was determined by observing the machine area and operators who are at risk of workplace accidents, specifically in the trimming, splitting or shaving, dyeing, hotplate, milling, and drying processes. The data collected includes both primary and secondary data. Primary data were obtained through direct observations in the production area and interviews with operators to identify potential work hazards in each activity. Meanwhile, secondary data consist of historical records available within the company.

Once the data were collected, analysis was conducted using the Hazard Identification and Risk Assessment (HIRA) method. HIRA involves identifying hazards, calculating risk levels, and determining whether the risks are acceptable [9]. Based on this analysis, potential hazards and their associated risk values were identified. Table 1, Table 2, and Table 3 show the matrix used for risk control following the HIRA method. Based on the calculation using the equation (Risk = Probability × Severity), this stage is crucial as it determines the steps and strategies for risk control. In risk analysis, assessing the magnitude of a risk involves evaluating the likelihood of occurrence (Probability/Likelihood) and the severity of its impact (Severity/Consequences).

Table 1.
Levels of probability

Level	Criteria	Statement
5	Almost certain	Happens very often
4	Likely	Often occur
3	Possible	Rarely happening
2	Unlikely	Very rare
1	Rare	Almost never happens

Table 2.
Levels of severity

Level	Criteria	Statement
1	Meaningless	No injuries, and minimal losses
2	Minor	Minor injuries, require medical unit treatment, and moderate losses
3	Moderate	Losts day of work, require hospital treatment, and significant losses
4	Major	Fatal physical injury, and great loss
5	Disaster	Cause of death, and very large losses

Table 3.
Risk matrix

Probability	Severity				
	1	2	3	4	5
5	L 5	M 10	H 15	H 20	H 25
4	L 4	M 8	H 12	H 16	H 20
3	L 3	M 6	M 9	H 12	H 15
2	L 2	L 4	M 6	M 8	M 10
1	L 1	L 2	L 3	L 4	L 5

Table 4.
Risk level matrix description

Level	Description
Extreme	Extreme risk, require urgent treatment as soon as possible
High	High risk, require training or seminar from management, scheduling corrective action as soon as possible
Moderate	Moderate risk, treatment done by certain management
Low	Low risk, require routine control procedures

In the risk matrix table, there are 4 levels of risk: low risk, moderate risk, high risk, and extreme risk, as shown in Table 4.

3. Results and discussions

The results of this study determine the risk value for each hazard source in the company, classified into levels marked with the following codes: E (Extreme Risk), H (High Risk), M (Moderate Risk), and L (Low Risk). These classifications are obtained by comparing the probability and severity values for each activity [10]. The following are the steps involved in the leather tanning process in Department C.

1. *Trimming*. In the trimming stage, which is the earliest stage in the leather tanning process, cowhides from suppliers are selected and cut according to company patterns and standards.
2. *Splitting dan Shaving*. Splitting involves separating the leather into grain and split (scrap), while shaving adjusts the thickness or smoothness of the leather surface according to customer requirements.

Table 5.
Potential dangers of the leather tanning process in Department C

No	Activity	Potential Danger
1	Trimming	Hands cut by knives, and skin irritation (physical)
2	Splitting dan Shaving	Hands caught by machines (physical)
3	Dyeing	Chemical hazards, slipping, and falling into the dyeing drum machine (physical and chemical)
4	Hotplate	Contact with hotplate, slipping, body aches, and skin irritation (physical and ergonomic)
5	Milling	Body aches, slipping, and falling into the milling drum (physical and ergonomic)
6	Drying	Body aches, and bumping into pipes (physical and ergonomic)

Table 6.
Likelihood levels of potential hazards in the wet tanning process in Department C

No	Acitivity	Type of Hazard	Probability	Risk
1	Trimming	Physic	2	Hands cut by knives.
2	Splitting dan Shaving	Physic	2	Hands caught by machnies.
3	Dyeing	Chemical	4	Chemical hazards.
		Physic	2	Slipping and falling into the dyeing drum machine.
4	Hotplate	Ergonomic	5	Poor working posture (body aches).
		Physic	2	Contact with hotplate, slipping, and skin irritation.
5	Milling	Ergonomic	5	Poor working posture (body aches).
		Physic	1	Slipping and falling into the milling drum machine.
6	Drying	Ergonomic	5	Poor working posture (body aches).
		Physic	3	Bumping into pipes.

Table 7.
Severity levels of potential hazards in the wet tanning process in Department C

No	Acitivity	Type of Hazard	Severity	Risk
1	Trimming	Physic	2	Hands cut by knives.
2	Splitting dan Shaving	Physic	4	Hands caught by machines.
3	Dyeing	Chemical	2	Chemical hazards.
		Physic	3	Slipping and falling into the dyeing drum machine.
4	Hotplate	Ergonomic	2	Poor working posture (body aches).
		Physic	3	Contact with hotplate, slipping, and skin irritation.
5	Milling	Ergonomic	2	Poor working posture (body aches).
		Physic	3	Slipping and falling into the milling drum.
6	Drying	Ergonomic	2	Poor working posture (body aches).
		Physic	2	Bumping into pipes.

Table 8.
Results of hazard identification and risk assessment in the leather tanning process of Department C

No	Activity	Hazard	Probability	Severity	Risk Rating	Level of Hazard
1	Trimming	Physic	2	2	4	Low Risk
2	Splitting dan Shaving	Physic	2	4	8	Moderate Risk
3	Dyeing	Chemical	4	2	8	Moderate Risk
		Physic	2	3	6	Moderate Risk
4	Hotplate	Ergonomic	5	2	10	High Risk
		Physic	2	3	6	Moderate Rsk
5	Milling	Ergonomic	5	2	10	High Risk
		Physic	1	3	3	Low Risk
6	Drying	Ergonomic	5	2	10	High Risk
		Physic	3	2	6	Moderate Risk

3. *Dyeing*. In the dyeing process, dyes and other chemicals are applied to meet finishing requirements.
4. *Hotplate*. This stage involves heating the dyed leather using a machine called a hotplate.
5. *Milling*. The milling stage is to produce soft leather. Essentially, the milling process is divided into two departments: A and C. The milling process in Department C is only used for certain types of leather.

Table 5 shows the potential dangers of the leather tanning process in Department C, whereas Table 6 and Table 7 show the probability and severity of those potential dangers, respectively. After assessing the likelihood and severity levels, the risk level for each activity in the leather tanning process in Department C is determined. This is presented in Table 8. The initial analysis stage involves classifying hazard sources by calculating the risk assessment. From this ranking, the probability and severity values of accidents are determined.

Table 9.
Risk level values

No.	Levels of Risk	Amount of Risk
1	Extreme Risk	0
2	High Risk	3
3	Moderate Risk	5
4	Low Risk	2

Based on the probability and severity calculations for the six activities in the leather tanning process, one risk has a probability of "never occurs," four risks are classified as "very rarely occurs," one risk as "rarely occurs," one risk as "often occurs," and three risks as "very often occurs." In terms of severity, five risks have minor severity, three have moderate severity, and one has major severity.

After determining the probability and severity values, the risk assessment codes for the hazard sources are assigned. This classification is based on risk level values. For example, Activity No. 1 has a probability value of 2 and a severity value of 2, resulting in a risk level of L (Low Risk). The distribution of risks in the leather tanning process includes 2 risks at a low-risk level, 5 risks at a moderate-risk level, 3 risks at a high-risk level, and no risks at the extreme-risk level. Table 9 shows the summary of the danger.

However, the overall risk assessment of the leather tanning process still indicates a significant number of high- and medium-risk hazards. Therefore, the shoe manufacturing company must implement preventive measures to minimize these risks. These measures include conducting Occupational Safety and Health (OSH) training and seminars, tightening supervision of all workers—particularly regarding the use of Personal Protective Equipment (PPE)—utilizing warning signs, Material Safety Data Sheets (MSDS), and scheduling corrective actions as soon as possible. These preventive steps aim to reduce and eliminate high- and medium-risk work activities, thereby minimizing the number of workplace accidents [11].

The Hazard Identification and Risk Assessment (HIRA) method is not only used in the leather tanning industry but is also widely applied across various sectors for risk analysis [12]. These sectors include automotive manufacturing [13], toxic waste management [14], industrial production [15], the Cable Tray Support Farming MSP Fabrication Project [16], the truck manufacturing industry [17], and nanotechnology laboratories [18]. Each of these industries employs HIRA to identify potential hazards, assess risks, and implement measures to ensure a safer and healthier working environment.

Extreme Risk is the highest risk category in HIRA, requiring immediate corrective action [19]. In this study, no activities were classified under the Extreme Risk category. However, several studies have identified Extreme Risks, such as a decline in soil fertility due to oil seepage, a lack of operational instructions for high-risk machinery, and the occurrence of fires caused by hazardous and toxic waste reactions. Recommendations for mitigating these risks include periodic machine inspections, installation of warning signs, and the implementation of fire alarms and fire suppression systems in hazardous material storage areas [20].

The second highest risk level in HIRA is High Risk, which requires training and immediate corrective actions to prevent accidents [21]. In this study, a key high-risk factor identified was poor worker posture, which can lead to workplace injuries. To address high-risk factors, companies should foster a multi-stakeholder commitment to health and safety (H&S) and ergonomics, empower workers through HIRA training, and encourage participation in H&S and ergonomics programs [22]. Several studies also recommend that workers take better care of their physical condition and perform occasional stretching exercises during work hours to prevent excessive muscle fatigue [23].

For Moderate Risk levels, employee awareness through warnings and reminders about workplace hazards is essential [24]. Common moderate risks include hand cuts from knives, exposure to chemical solutions, falls, and machine collisions. Several studies suggest that assistive tools can help prevent workplace accidents, such as wearable sensors and real-time data analytics systems. These technologies play a critical role in Total Worker Health (TWH) by monitoring, managing, and predicting work risks in real-time, thereby improving safety and operational efficiency [25].

The lowest risk level in HIRA is Low Risk, which requires routine checks of standard operating procedures (SOPs) to minimize accidents [26]. Effective SOPs include regular inspections of fire extinguishers, first aid kits, and personal protective equipment to ensure proper functionality [27]. Identifying potential hazards and encouraging workers to report abnormal conditions are crucial for preventing workplace accidents [28]. For example, workers may suddenly slip due to an unclean work area, emphasizing the need for strict hygiene and safety standards.

To minimize workplace accidents, recommended control measures include substitution, elimination, engineering controls, administrative controls, and the use of PPE [29]. Additional risk reduction strategies include adhering to SOPs, using PPE appropriate to specific activities, conducting regular inspections, and avoiding hazardous areas [30].

4. Managerial implications

The implementation of Hazard Identification and Risk Assessment (HIRA) offers significant benefits to managers in the manufacturing industry.

First, HIRA systematically identifies potential hazards, allowing managers to implement effective preventive measures to reduce workplace accidents and minimize related costs, such as equipment damage and repair expenses.

Second, HIRA ensures compliance with international safety standards like ISO 45001 and government regulations. This not only helps prevent legal sanctions but also enhances the company's reputation as a safe and responsible workplace.

Third, HIRA fosters employee involvement in the hazard identification process, promoting a stronger and more collaborative safety culture. This increased awareness encourages employees to be more proactive and vigilant in maintaining workplace safety.

Finally, HIRA enables continuous monitoring and re-evaluation of risks, ensuring that control measures remain effective and relevant as operational conditions evolve.

5. Conclusions

The identified hazards in Department C of this company include 10 potential hazards, consisting of 6 physical hazards, 1 chemical hazard, and 3 ergonomic hazards, with 10 risks across 6 work activities: Trimming, Splitting or Shaving, Dyeing, Hotplate, Milling, and Drying. Based on the risk assessment results, 3 hazards are categorized as high risk, 5 as moderate risk, and 2 as low risk.

The factors contributing to these hazards include a lack of supervision and control by the occupational safety and health management team, worker negligence in using personal protective equipment (PPE), and insufficient use of warning signs.

To mitigate these risks, preventive measures should include using complete safety equipment such as safety shoes, masks, earplugs, gloves, safety helmets, and wearpacks, conducting regular machine maintenance and periodic equipment checks, providing safety and health training to all workers, and ensuring strict company supervision regarding occupational safety and health (OSH) management.

This study has several limitations. First, the scope is limited to Department C of a specific company, making it difficult to generalize the findings to other departments or industries. Second, the reliance on qualitative data through observations and interviews may lead to subjective interpretations. Lastly, the study does not assess the long-term effectiveness of the recommended preventive measures. Future research could expand the scope and use quantitative methods to strengthen the reliability of the results.

Declaration statement

Henny Henny: Conceptualization, Methodology, Writing-Original Draft. Muhammad Aditya, Denmas Adityo Sumaryatno: Collecting data. Agus Heri Setya Budi, Ade Sri Mariawati: Writing-Review & Editing.

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The authors confirm that the data supporting the findings of this study are available within the article or its supplementary materials.

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