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Exploration of Occupational Safety Practices in Chemical Waste Management: A Case Study in the Printing Industry

Juwairiah[1*]

[1]Graphic Engineering Study Program, Politeknik Negeri Media Kreatif PSDKU Medan, Indoneisa

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Corresponding Author:
Author Name*: Juwairiah
Email*: juwairiah@polimedia.ac.id

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ABSTRACT

The printing industry generates chemical waste that has the potential to endanger workers' health and the environment. This study aims to explore occupational safety practices in chemical waste management within the printing industry and to identify challenges in the implementation of occupational health and safety (OHS) procedures. This research employed a qualitative case study method, with data collected through semi-structured interviews, direct observations, and document analysis. The primary research instrument was the researcher, supported by interview guidelines, observation sheets, and document recording formats. Informants were selected using purposive sampling, consisting of production technicians, OHS (Occupational Health and Safety) department heads, and waste management personnel. The data were analyzed using the Miles & Huberman technique, which includes data reduction, data display, and conclusion drawing. The results indicated that the use of personal protective equipment (PPE) and the implementation of standard operating procedures (SOPs) for chemical waste management were not yet optimal, and occupational safety training remained predominantly theoretical with limited practical application. In conclusion, there is a need for more intensive practical training, updated and easily accessible SOPs, and enhanced worker awareness.

Keywords: occupational safety, chemical waste, printing industry

INTRODUCTION

The printing industry is one of the manufacturing sectors that extensively uses chemical substances in its production processes, such as solvent-based inks, cleaning fluids, as well as binders and dyes. The use of these chemicals is inherently associated with potential hazards to occupational health and safety (OHS) and environmental pollution if not managed properly. The emerging risks include exposure to hazardous substances, explosions due to flammable materials, and environmental damage resulting from improper waste disposal. Therefore, the implementation of occupational safety practices in chemical waste management is a crucial aspect for ensuring the sustainability of the printing industry while protecting workers and the surrounding environment [1].

Occupational health and safety (OHS) in chemical-based industries primarily focuses on preventing workplace accidents and illnesses caused by exposure to hazardous chemicals [2]. In the context of the printing industry, the chemical waste produced, such as residual ink, solvents, and fixer solutions, is classified as hazardous and toxic waste (B3) in accordance with Government Regulation No. 101 of 2014. The management of such waste requires not only awareness of its potential dangers but also the implementation of standard procedures that align with OHS principles and environmental management.

A previous study by [3] found that in many small and medium-sized industries, the implementation of OHS procedures related to chemical management remains low, particularly in the use of personal protective equipment (PPE) and documentation of waste management standard operating procedures (SOPs). Meanwhile, [4] in their research indicated that although awareness of the hazards of chemical waste has increased, formal waste management implementation is carried out by only a small portion of printing industries, especially those with ISO 14001 certification. The study by [5] emphasized that many printing industries do not separate hazardous waste from domestic waste, leading to a high risk of environmental contamination. Another study by [5] revealed that training on the dangers of hazardous chemicals in the printing sector has not yet become a routine priority in many companies. These findings indicate that previous research has primarily focused on risk identification and regulatory compliance, while few studies have thoroughly explored how daily occupational safety practices in chemical waste management are actually implemented in the field.

This study offers scientific novelty by conducting an in-depth exploration of the occupational safety practices implemented by workers and management in the printing industry in handling chemical waste. The approach used is qualitative, with a focus on the

experiences, understanding, and operational challenges faced by workers, rather than merely on administrative compliance aspects. This study is expected to provide a more contextual and practical depiction of field practices, which have been rarely addressed in previous research.

This study aims to explore the occupational safety practices implemented in chemical waste management within the printing industry and to identify the challenges and obstacles encountered in the implementation of occupational health and safety (OHS) procedures related to chemical waste management.

RESEARCH METHOD

1. **Type of Research**

   This study used a qualitative approach using the case study method. The qualitative approach was chosen because it is suitable for exploring in depth the subjective experiences and social context of occupational safety practices in chemical waste management [7]. The case study method allows for a more comprehensive analysis of the specific and complex conditions within the printing industry [8].

2. **Research Location and Time**

   The research was conducted at a medium-scale printing industry in the city of Medan, which utilizes various chemical substances in its production process. The study took place from February to March 2025.

3. **Research Subjects**

   The research subjects were selected using purposive sampling, which involves choosing informants considered to be knowledgeable and directly involved in chemical waste management. This technique was used because it allows the researcher to obtain more relevant and in-depth data from competent sources [9].

The research subjects consisted of: production technicians, the head of the OHS department, and waste management personnel.

4. **Data Collection Techniques**

   Data were collected through:

   a. **Semi-structured interviews,** to obtain in-depth information on the informants' experiences and perceptions.
   b. **Direct observation,** to observe actual occupational safety practices.
   b. **c. Document analysis,** such as SOPs, workplace accident reports, and OHS training records [9].

5. **Research Instruments**

   The primary instrument in this study was the researcher (human instrument), supported by interview guidelines, observation sheets, and document recording formats.

6. **Data Analysis Technique**

   Data were analyzed using the Miles and Huberman model [10], which consists of three stages:

   a. Data reduction: selecting data relevant to the focus of the study.
   b. Data display: organizing data in the form of matrices, tables, and narratives.
   c. Conclusion drawing: interpreting the data that has been analyzed.

7. **Data Validity**

   To ensure data validity, triangulation techniques were employed [11], including:

   a. Source triangulation (using multiple informants).
   b. Technique triangulation (using interviews, observations, and document analysis).
   c. Time triangulation (repeating data collection at different times).

8. **Research Flow**

   The following is the research flow that illustrates the steps undertaken in this study:

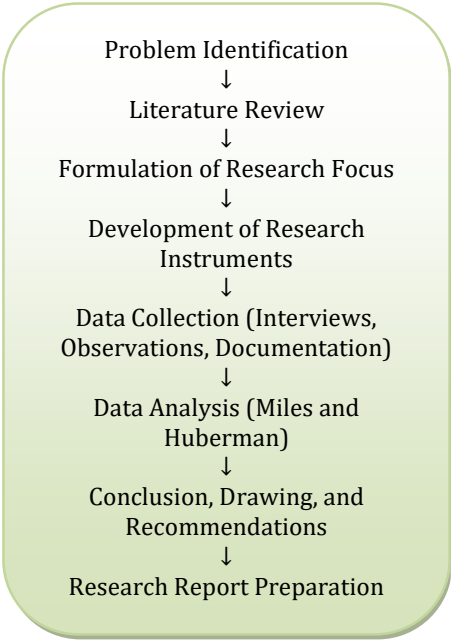

Figure 1. Research Flow

Figure 1 illustrates the systematic steps in this study, starting from problem identification to research reporting. This process is iterative, meaning that data collection and analysis may be conducted repeatedly to deepen the findings [7].

RESULTS AND DISCUSSION

The research findings were obtained through data collection consisting of interviews, direct observations, and document analysis related to occupational safety practices in chemical waste management within the printing industry. Based on the data analysis conducted, several key findings were identified concerning occupational safety practices and chemical waste management, including the following:

a. Use of Personal Protective Equipment (PPE)

Most workers in the printing industry use standard personal protective equipment (PPE), such as masks, gloves, and eye protection. However, the use of complete PPE, such as body protection (aprons or chemical-resistant suits), is still rarely implemented, particularly during the cleaning of tools and machines involving solvent-based chemicals. The use of personal protective equipment (PPE) is presented in Table 1.

Table 1. Data on the Use of Personal Protective Equipment (PPE)

Informant	Types of PPE Used	PPE Compliance Rate	Additional Notes
Production Technician	Mask, Gloves, Eye Protection	75% of workers use complete PPE	Some workers only use masks and gloves.
Head of OHS	Mask, Gloves, Eye Protection	100% use standard PPE	Use of full PPE is lacking during machine cleaning activities.

The use of PPE is one of the occupational safety practices that can prevent exposure to hazardous chemicals, which may cause skin irritation, respiratory disorders, or even poisoning. According to a study by [2], the use of PPE is a highly important preventive measure to protect workers from the risks posed by hazardous chemicals. However, the low usage of complete PPE may be attributed to a lack of training or insufficient awareness of the risks associated with chemical exposure, as also found by [4], who stated that many workers in the printing industry still underestimate the importance of PPE.

b. Chemical Waste Management

The chemical waste management in this company has not been fully aligned with existing regulations. Chemical waste, such as residual ink and solvents, although separated from domestic waste, is often still disposed of without following proper procedures. Several personnel admitted that the management of chemical waste relies more on experience and intuition rather than on clearly defined standard operating procedures (SOPs). Chemical waste management is presented in Table 2.

Table 2. Chemical Waste Management

No	Informant	Chemical Waste Management Process	Procedures Followed	Additional Notes
1	Production Technician	Separation of ink and solvent waste	Not fully compliant with SOP	Waste is often discharged into public drainage without further treatment.
2	Head of OHS	Separation and treatment of ink waste	Mostly follows SOP	No licensed hazardous waste disposal system is currently in place.

Improper waste management practices can lead to environmental pollution and increase health risks for workers. This is consistent with the findings of a study by [5], which stated that many printing industries still face difficulties in separating hazardous waste from non-hazardous waste, potentially increasing negative environmental impacts. One of the main reasons is the lack of adequate facilities and budget constraints for more environmentally friendly waste management.

c. Occupational Safety Training

Most workers in the printing industry reported having participated in occupational safety training. However, the training provided focused more on general knowledge about chemical hazards and offered limited discussion on detailed procedures for waste management. This indicates that the existing training is not sufficiently comprehensive in covering the technical aspects of chemical waste management. Occupational safety training is presented in Table 3.

Table 3. Occupational Safety Training

No	Informant	Type of Training Received	Regularly Conducted	Additional Notes
1	Production Technician	General OHS training and chemical hazard awareness	Not regular (once a year)	Lack of practical content in training related to chemical waste management.
2	Head of OHS	OHS training related to chemical waste management	Regular (every 6 months)	However, the training is more theoretical than practical.

Inadequate occupational safety training can affect workers' knowledge and awareness in handling chemical waste safely. The study by [6] showed that training that emphasizes only general theory without in-depth practical field application risks reducing its effectiveness. Furthermore, sporadic and irregular implementation of training may result in workers not fully understanding the safety procedures that must be applied in emergencies.

d. Documentation and Recording of OHS Procedures

The documentation and recording of OHS procedures in the printing industry are still not well organized. Some existing SOPs are not regularly updated and are difficult for workers to access when needed. In addition, not all chemical waste management activities are recorded systematically. The availability and accessibility of SOPs are presented in Table 4.

Table 4. Data on SOP Availability and Accessibility

No	Informant	SOP Availability	SOP Accessibility	Additional Notes
1	Production Technician	SOP for chemical waste management is available	SOP is difficult to access in general	Some SOPs are outdated and not updated.
2	Head of OHS	Complete SOPs are available	SOPs are accessible only to managers	SOPs need to be updated and made more accessible to all employees.

Well-organized SOPs are essential for maintaining consistency in occupational safety practices in the field. This aligns with the findings of [3], which stated that compliance with standards and procedures in small and medium-sized industries, including printing, greatly depends on clear documentation that is easily accessible to all relevant parties. The absence or incompleteness of such records may lead to procedural errors, ultimately increasing potential hazards for both workers and the environment.

e. Workers' Awareness and Concern for OHS

The level of workers' awareness and concern for occupational health and safety varies significantly. Some workers demonstrate a high level of concern for the implementation of OHS procedures, while many others pay little attention to the existing procedures, particularly during chemical waste management, which is often not considered part of their main responsibilities. Workers' awareness and concern for OHS are presented in Table 5.

Table 5. Data on Workers' Awareness and Concern for OHS

No	Informant	Concern for OHS	Actions Displayed	Additional Notes
1	Production Technician	Increasing	Uses PPE most of the time	Some workers are still undisciplined in following OHS procedures.
2	Head of OHS	High	Directly reminds workers	Concern is still lacking among workers in the field.

Workers' awareness of OHS is essential for creating a safe working environment. The study by [4] revealed that workers' concern for OHS can be improved through more intensive communication between management and workers, as well as through continuous training and guidance. Furthermore, in this context, concern for chemical waste management needs to be strengthened to ensure that occupational safety practices are implemented more consistently.

Based on Table 5, it is evident that occupational safety practices in chemical waste management within the printing industry still require significant improvement. The lack of comprehensive training, inconsistent use of PPE, and improper chemical waste management are some of the key issues that must be addressed promptly. Nevertheless, this study also indicates that there is awareness among certain parties to improve occupational safety practices through training and the implementation of SOPs, although their implementation has not yet been optimal.

These findings are consistent with previous studies by Yulianto [4] and Agustin [12], which also indicated that chemical waste management in the printing industry is often hindered by the lack of adequate facilities, limited technical knowledge, and challenges in consistently implementing OHS procedures. Therefore, to achieve significant improvements, further efforts are needed in terms of training, waste management facilities, and managerial support for a safety-oriented workplace culture. The results of OHS implementation in the printing industry are presented in Table 6.

Table 6. OHS Implementation in the Printing Industry

Aspect	Findings	Description
Use of PPE	Inconsistent use of PPE	Workers only use part of the required PPE. This is due to a lack of training on the importance of complete PPE in preventing chemical exposure.
Chemical Waste	Suboptimal separation	The lack of facilities and unclear SOPs results in inadequate

Aspect	Findings	Description
Management	and management	chemical waste management, increasing the risk of environmental contamination.
OHS Training	Irregular and impractical training	Training focuses more on theory than on practical field application. Continuous training involving practical simulations is needed.
Documentation and Recording	SOPs are suboptimal and hard to access	OHS procedures need to be more systematic and accessible to all workers to ensure compliance with safety protocols.
Awareness of OHS	Awareness is increasing, but uneven	Work culture and inconsistent coaching contribute to low awareness among some workers.

The implementation of OHS in the printing industry indicates that there have been efforts to improve occupational safety practices in chemical waste management. However, many challenges still need to be addressed, particularly in terms of training, waste management facilities, and compliance with established procedures.

Based on the results of observations and interviews, several key factors were identified that influence both compliance and non-compliance with occupational safety (OHS) procedures in chemical waste management:

1. Knowledge and Training: A lack of technical understanding regarding the hazards of chemical waste and its handling procedures is a primary factor contributing to low compliance [4], [12]. The training provided is general and theoretical, thus failing to equip workers with hands-on practical skills.
2. Availability and Accessibility of SOPs: The available SOP documents have not been regularly updated and are difficult for all workers to access. This condition leads workers to rely more on intuition or habitual practices rather than standard procedures [13], [1].
3. Leadership and Supervision: The lack of direct supervision and regular monitoring by management contributes to weak enforcement of discipline regarding OHS procedures. The study by Setiawan [1] demonstrated that strong leadership plays a significant role in shaping a safety-oriented workplace culture.
4. Facilities and Resources: The unavailability of supporting facilities, such as hazardous waste (B3) storage areas or complete personal protective equipment, also affects the level of compliance [14], [15].
5. Safety Culture: The collective awareness among workers regarding the importance of occupational safety remains low. Some workers even perceive the use of PPE or proper waste disposal procedures as not being part of their primary responsibilities [12], [16].

These findings are consistent with previous studies, as stated by Yulianto [4] and Agustin [12], which emphasized that compliance with OHS largely depends on a combination of continuous training, managerial leadership, and workplace culture.

CONCLUSION

Occupational safety practices in chemical waste management within the printing industry have not yet been implemented optimally. Several challenges were identified, including the lack of practical training, limited facilities, and low worker awareness. Therefore, it is necessary to update SOPs, strengthen the safety culture, and conduct continuous training to ensure that occupational safety can be effectively implemented.

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