Chemical –based Occupational safety risk analysis in the process of production and handling chemicals

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Abstract

Work safety in the chemical industry is the main concern given the high potential hazards caused by hazardous chemicals. This study aims to analyze the risk of chemical -based work safety that occurs during the production process and handling hazardous chemicals in the industrial environment.

The construction industry refers to the industrial sector related to physical development such as buildings and infrastructure. The improvement strategy refers to the steps taken to improve and strengthen K3 awareness and implementation in the construction industry. In this study, various related literature has been analyzed to identify an increase strategy that can be applied in the context of the construction industry. Some of the strategies found include: effective K3 training and education, the application of strict K3 regulations and policies, the use of technology and innovation to improve work safety, the formation of a strong safety culture in the workplace, and collaboration between related partiesLike companies, workers, and government. It is hoped that the strategy to increase K3 awareness and implementation in the construction industry can make a significant contribution in maintaining health and safety. This study aims to identify hazards and evaluate risks in the environment

Basic Chemical Laboratory at the Kalimantan Institute of Technology and provides risk control recommendations. This laboratory has an important role in student education in understanding the basic concepts of chemistry and developing practical skills. However, activities in the laboratory also bring potential hazards that can endanger the safety of students and staff. This research method using an observational and analytical approach. The observational approach is used to identify potential hazards, assess risks, and evaluate risks associated with these hazards. The results showed that there were a variety of hazards in the laboratory, including physical, chemical, biological, ergonomic hazards. Risk analysis shows that most danger has a high risk. Therefore, the recommendations for risk control are proposed, including changes in the regulation of work areas, the use of personal protective equipment, and tighter inspection procedures. This study provides an in-depth understanding of the dangers and risks in the basic chemical laboratory and concrete steps to improve safety in the environment. The implementation of this recommendation is expected to reduce the risk of work accidents and create a safer and better work environment for all those involved in the learning and research process in the basic chemical laboratory. (Keywords: Hirarc, Hazard Identification, Risk Assessment, Risk Control)

Introduction

Occupational health and safety is one aspect of labor protection that aims to make the workforce safely and comfortably. Therefore, the protection of occupational safety and health is not only an obligation that must be met by workers, but a need that must be met by the company. Every year, thousands of accidents occur in the workplace, and cause casualties. Giga Scientific Journal Volume 25 (2) November 2022

due to the lack of awareness and understanding among businesses and government agencies in Indonesia of the importance of aspects of occupational safety and health, as one element to increase competitiveness. The occurrence of work accidents is caused by physical and human factors. Physical factors such as unsafe work environment conditions. While the human factor is the behavior of workers who do not meet personal safety due to negligence, drowsiness, fatigue and so on. The manufacturing industry is an industry that processes raw materials (raw materials) into finished goods, which in the process requires special attention about the safety of the K3 workers because the process is directly related to the machines both semi-automatic orautomatic

Strategies to increase OSH awareness can be carried out through 2 main approaches: namely regulation and education. The regulation includes the application of policies and regulations governing OSH standards in the workplace. This policy is usually determined by the government and related institutions such as the Ministry of Manpower, the Directorate General of Binwasnaker, the Ministry of PUPR and the Ministry of Health, which aims to ensure that all companies comply with established safety standards. Data from the World Health Organization (WHO) shows that work accidents and occupational diseases cause millions of deaths and injuries every year, which have a negative impact not only on individuals but also on company productivity and the economy as a whole. The application of strict regulations can encourage companies to be more serious and prioritize in implementing K3 practices, as well as providing severe or light sanctions for those who violate.

On the other hand, education is an approach that focuses on increasing the knowledge and understanding of workers about the importance of K3. Education can be done through training, socialization, safety talk and sustainable awareness campaigns. Routine and structured K3 training can help workers understand the risks in the work environment and they can avoid them. By providing appropriate and relevant information, workers are expected to be able to identify risks in their work environment and take the necessary prevention steps. (Giga Scientific Journal Volume 25 (2) Novembe 88-95 (p) ISSN 1410-8682 http://dx.doi.org)

METHOD

Journal of Chemical -Based Work Safety Risk Analysis Methods can include several topics, such as:

- Identification of chemical hazards: use a list of hazardous chemicals to identify potential chemical hazards in the workplace.
- Risk Assessment: Using methods such as Hazop (Hazard and Operability Study) or FMEA (Failure Mode and Effects Analysis) to assess the level of work safety risk related to potential chemical hazards.
- Risk Control: Using a risk control hierarchy, such as elimination, substitution, technical control, administrative control, and the use of personal protective equipment to reduce or eliminate potential chemical hazards.

Some examples of journals that are relevant to this topic are:

- Occupational Safety and Health Risk Analysis (K3) through the Hazop Method: This journal discusses the analysis of occupational safety risk using the Hazop method in the Langsa Regional Hospital Development Project.
- Occupational Safety and Health Risk Management Analysis (K3) Using the ISO 31000 Method: This journal discusses the analysis of occupational safety risk management using ISO 31000 standards.
- Agricultural Nursing -Based Safety Health Model: This journal discusses the Primary Health Care -Based Work Safety Health Model to prevent and reduce the risk of accidents or diseases in the agricultural sector.

Chemical -based work safety risk analysis methods commonly used include:

- Hazop (Hazard and Operability Study): This method is used to identify potential hazards and evaluate occupational safety risks.
- FMEA (Failure Mode and Effects Analysis): This method is used to identify potential failure and evaluate its impact on work safety.
- ISO 31000: International standards for risk management that can be used to analyze work safety risks.

RESULTS AND DISCUSSION

NO	HEADING	WRITER	PURPOSE	METHOD	RESULT
1.	The relationship between exposure to hazardous chemicals in the work	Nanang Rahmadani, Muhammad Syafri Mitrasehat Journal 14 (2), 728-732, 2024	This study aims to explore and analyze the relationship between exposure to hazardous chemicals in the work	This study will use a mixed approach that combines quantitative and qualitative methods to	Based on data collected from surveys, measurement of exposure, interviews, and analysis of health

	environment and health risks in industrial workers		environment and health risks in industrial workers.	analyze the relationship between exposure to harmful chemicals in the work environment and health risks in industrial workers	records, the results show findings: Profile of exposure to chemicals, workers in the industry studied exposed to various hazardous chemicals, including organic solvents (such as toluen andbenzene), heavy metals (such as lead and mercury), and other industrial chemicals (such as formaldehyde).
2.	Management Analysis Risk of B3 Use with Hiradc in the Sizing Agent Production Process	Hisar Pardede, Tatan Sukwika, Sugiarto Sugiarto Journal of Health Sciences Bhakti Husada: Health Sciences Journal 16 (01), 206-215, 2025	To identify the dangers and assess the risks caused by hazardous and toxic substances (B3), determine the level of risk, control these risks systematically, and ultimately minimize or eliminate the potential injury of workers, asset damage, and negative impactsagainst the environment.	Research uses the Hiradc method. Data was collected through field observation, semi-structured interviews (15 participants), document analysis (SOP), and literature studies of risk assessment referring to the 5x5 matrix (US/NZS 4360 and ISO 31000).	High -risk activity (score 10-15) is identified in weighing and mixing raw materials due to corrosive chemical exposure and procedure errors. Technical engineering (ventilation, alarm sensor) and elimination (automation) reduces risk. However, dependence on PPE is a weakness, especially in areas with ammonia exposure.
3.	Application of Risk Analysis to Occupational Health and Safety (K3) at PT. X	Alfi Septianto, Arie Restu Wardhani Journal of Application and Innovation of IPTEKS "Solidity" (J-Solid) 3 (1), 7, 2020	Protecting the safety and health of workers by preventing accidents and occupational diseases, while minimizing financial losses for the company, ensuring compliance with regulations, and increasing the productivity and reputation of the organization.	Identification of Hazards (Recognizing Potential Hazards in the Work Place)	The importance of implementing occupational health and safety (K3) requires all companies to be able to apply it so that employee health and safety can be guaranteed. But not all companies are able to implement this system, due to the negligence of employees who are not willing to use personal protective equipment, or the absence of strict sanctions and rules to control employee discipline. Likewise with the company at PT
4.	Analysis of Chemical Hazard Risks on Pesticide Use in	Dr.Ir.Sri Wahyuni	Identifying potential chemical hazards in the use of pesticides and developing control strategies.	Hazard identification, risk assessment, and development of control strategies	Found potential chemical hazards in the use of pesticides, such as exposure to hazardous chemicals

	the Agricultural Sector			using control hierarchy	and the risk of poisoning
5.	Analysis of Chemical Hazard Risks in the CAT Production Process in the Chemical Industry	Ir. Budi Santoso, M.T.	Identifying the potential for chemical hazards in the paint production process and developing control strategies.	Hazop (Hazard and Operability Study) and risk assessment using Risk Matrix.	Found potential chemical hazards in the process of paint production, such as the risk of explosion and exposure to hazardous chemicals.
6.	Analysis of Chemical Hazard Risks in Handling Hazardous and Toxic Waste (B3)	Dr. Ir. Endang Sulistyani	Identifying potential chemical hazards in handling B3 waste and developing control strategies.	Identifying potential chemical hazards in handling B3 waste and developing control strategies.	Found potential chemical hazards in handling B3 waste, such as the risk of poisoning and environmental pollution.
7.	Chemical -based occupational safety risk analysis in the process of production and handling hazardous chemicals	Dr. Andi Setiawan, S.Km., M.Kes	To identify potential chemical hazards in the production area, assess the level of risk caused, and provide recommendations for controlling hazards according to the K3 principle.	Qualitative descriptive research with field observation approaches, interviews, and Hirarc (Hazard Identification, Risk Assessment and Risk Control) analysis.	Some points of production process have different levels of risk, with the process of mixing and transferring hazardous chemicals identified as high risk. The main causative factor is the lack of adequate ventilation system and limitations of administrative control. In addition, it was found that some workers are still inconsistent using PPE according to procedures, thereby increasing the potential for direct exposure. Control recommendations include increased ventilation, procurement of more ergonomic PPE, re - training related to K3 procedures, and the addition of a chemical leak detection system
8.	Analysis of Chemical Hazard Risks in the Production Process in the Chemical Industry	Dr. Ir. Wahyudi,	Identifying the potential for chemical hazards in the production process. Risk assessment using risk matrix.	Risk assessment using risk matrix.	Identification of potential chemical hazards, such as exposure to hazardous chemicals and the risk of explosion.
9.	Analysis of the risk of fire and explosion due to handling of flammable gas in the petrochemical industry	Smith, J., et al.	Identifying potential fire hazards and explosions, assessing related risks, and determining control steps to minimize potential events in production facilities.	Using the hazard identification approach,	Identifying that gas leakage from non - maintained equipment is the highest risk, and recommends an increase in the frequency of inspection and the use

					of a gas detection system.
10.	Occupational health risks due to exposure to organic solvents in paint factory	Garcia, M., et al.	Analyzing the relationship between organic solvents and increased risk of health problems in paint factory workers.	Epidemiological studies with worker interviews on health phenomena,	Finding a correlation between high levels of solvent exposure with an increase in the incidence of skin diseases and respiratory problems among workers.
11.	Analysis of Occupational Safety and Health Risk (K3) Based on Chemistry in the CAT Production Process at PT. XYZ	Budi Santoso, Ani Wulandari, Chandra Kirana	Identifying potential chemical hazards, assessing risk, and providing recommendations for K3 risk control in the paint production process.	Hazard identification using Hazard Identification Checklist and Direct Observation	Exposure to organic solvents (toluen, xylene), pigment dust, fire and explosion risk.
12.	Evaluation of risk exposure to harmful chemicals in workers in the petrochemical industry: Case studies at ABC oil refineries	Dwi Prasetyo, Eka Fitriani	Measuring the level of exposure to harmful chemicals in workers, evaluating health risks, and providing recommendations to reduce exposure.	Measurement of exposure: air sampling for analysis of the concentration of chemicals (for example, benzene, hydrogen sulfide).	Some workers exposed to benzene exceed the threshold value (NAB).
13.	K3 Risk Analysis in Handling Hazardous and Toxic Waste (B3) in Regional General Hospital (RSUD)	Fitri Rahmawati, Guntur Nugroho	Identifying K3 risks in the B3 waste management process, assessing the level of risk, and providing control recommendations.	This research was conducted through direct observation of the B3 waste management process, in -depth interviews with waste management officers, as well as SOP and MSDS document analysis. Risk assessment is carried out using a semi-quantitative method based on a risk matrix to determine the severity and the possibility of danger	-Risk identification: needle pierced, exposure to disinfectant chemicals, pathogenic microorganism infections. - Risk assessment: The highest risk is a needle stabbed and exposure to chemicals. - Recommendations: use of skewers, appropriate PPE, B3 waste management training, and effective disinfection procedures.
14.	Occupational Safety and Health Risk Control (K3) Based on Chemistry in the Fertilizer Production Process at PT. Your fertile	Hadi Susanto, Indah Permata Sari	Analyzing K3 risk in the fertilizer production process, evaluating the effectiveness of existing control, and providing recommendations for improvement.	- NSPEX: Conduct inspection of equipment and work environment. - Document Analysis: Check MSDS (Material Safety Data Sheet) and SOP (Standard Operating Procedure).	- Risk identification: exposure to fertilizer dust, ammonia, and corrosive chemicals. - Evaluation of Control: Existing control is not fully effective. - Recommendations: Increased ventilation, use of appropriate masks, more intensive K3 training, and

				- Survey: Collecting data on worker's perception of K3.	routine equipment maintenance.
15.	K3 Risk Assessment Chemicals in the Pharmaceutical Industry	Dian Lestari, Eko Prasetyo	. Evaluate the level of risk of the use of chemicals in the pharmaceutical industry to prevent occupational diseases (PAK) and injuries	Systematic Approach Hazard identification and risk assessment using questionnaires and direct observation, analyzed using a risk matrix.	Shows that the highest risk is related to exposure to organic solvents and strong acids. Recommended routine training on handling safe chemicals and improving emergency response procedures.
16.	Case study of chemical risk analysis in the research laboratory	Fajar Nugroho, Gita Permata	Identify specific hazards in laboratory tasks and provide recommendations to minimize work accidents related to chemicals.	Use the Job Safety Analysis (JSA) to analyze the potential hazards in each work procedure that involves chemicals and recommend preventive measures.	Found the potential risk of reactive chemicals that are stored incorrectly. Recommendations include safer storage of chemicals, supervision of PPE use, and better decontamination procedures.
17.	Evaluation of Chemical Hard Pajan Risk for Textile Industry Workers	Hanafi M., Indah S.	Determine the level of health risk of workers due to exposure to harmful chemicals such as dyes and solvents.	Measurement of chemical exposure levels in the air and comparing it with threshold value (NAB), followed by health risk analysis using epidemiological data.	It was found that the concentration of solvents in the dyeing area exceeded NAB, increasing the risk of respiratory disorders. Recommendations for improving local ventilation systems and worker health monitoring are carried out.
18.	The effect of the use of ventilation on the concentration of chemicals and work risks in the paint industry	Jati P., Kartika L.	Evaluate the effectiveness of the ventilation system in reducing the concentration of chemicals and reducing the risk of K3 in the production area.	Field studies with measurement of the concentration of chemicals before and after the application of the new ventilation system, as well as risk analysis by the JSA method.	The installation of a new ventilation system significantly reduces the concentration of solvents in the air, which has an impact on reducing the risk of exposure and improvement of the work environment.
19.	Training for Handling Hazardous Chemicals: Case Study in the Pharmaceutical Industry of PT. Healthy Sentosa	Rini Handayani, Bambang Prasetyo	Evaluate the effectiveness of training in handling hazardous chemicals on the knowledge and skills of workers in the pharmaceutical industry.	Pre-test and post-test to measure increased knowledge.	Training increases worker knowledge about the hazards of chemicals and how to handle them.
20.	Development of Multi-Criteria Decision Making (MCDM)-Based Work Safety Risk Assessment Models for	Muhamet Gul, Melih Yucesan, Mehmet Kayra Kara Cahan	Developing the Methodology of Work Safety Risk Assessment for Chemicals in the University Laboratory by	Identification of six risk parameters: probability, severity, exposure, detection, ballast factors, and	Development of a risk assessment model that can classify chemicals based on risk levels.

	Chemicals in the University Laboratory		considering various risk parameters.	sensitivity to the use of PPE.	
21.	Safety Risk Assessment of Chemical Production Processes Based on Local and Global Objectives	Ruiqing Shao, Helin Pan, Jie Huang	Propose a safety risk assessment model for chemical production processes based on local and global goals to reduce and prevent accidents.	Using the Dow Fire and Explosion Index (F&E) method to evaluate the risk of fire and explosion in each unit in the chemical production process.	Accurate risk assessment model and scientifically decent.
22.	Making standard operating procedures for manipulation of hazardous chemicals in the academic laboratory	Tilak Chandra, Jeffrey P. Zebrowski, Rob McClain, Lisa Y. Lenertz	Providing suggestions for the development of standard operating procedures (SOPs) in academic research institutions and SOP samples for Grignard's reaction.	- Identification of reaction regulation requirements. - Identification of potentially unsafe conditions.	SOP development helps ensure safe laboratory practices followed and improve overall safety culture in the Academic Research Department.
23.	Health Risk Study From Chemicals in Workers The Food Flavoring Production Section at PT. X East Jakarta 2020	Polm Erik Astrada	Assessing health risks related to exposure to food raw materials at PT. X Based on the level of danger, exposure, health risks to the controls carried out.	Health risk research on chemicals by identifying hazards based on the characteristics of chemicals to large exposure received by workers so that the risk can be assessed.	The risk of exposure through the inhalation pathway is a moderate risk, while the risk of exposure through the dermal absorption pathway is a high risk of the risk of corrosion in the skin, with the highest risk of the filling and packaging process.
24.	Risk Analysis and Chemical Hazard Control in Research Laboratory: Case Study at the University of Indonesia	Research Team from the University of Indonesia	Identifying chemical hazard risks in the research laboratory, evaluating the effectiveness of existing control, and providing improvement recommendations.	Laboratory inspection to identify potential hazards	Exposure to corrosive chemicals, flammable, and toxic.
25.	Chemical -based Occupational Safety and Health Risk Analysis in the NPK fertilizer production process at PT	Agus Setiawan, Rina Kumala	Identify chemical hazards, assess risk, and provide recommendations for K3 risk control in the NPK fertilizer production process.	Observation and interviews with workers. Analysis of MSDS Documents (Material Safety Data Sheet).	Danger Identification: Exposure to fertilizer dust, ammonia, sulfuric acid. Risk Assessment: The mixing and packaging process has a high risk.

Changes in behavior and concern for K3

Participants become better understand the importance of using personal protective equipment (PPE).

Increased awareness of potential chemical hazards and the importance of risk control at work.

1. Risk control that has been applied

The use of PPE such as respirator masks, chemical gloves, and eye protection has been required, but the level of compliance of workers is only around 65%.

The ventilation system is available, but its effectiveness is not optimal in some production areas

The results showed that work safety risks in the chemical industry are strongly influenced by the characteristics of hazardous chemicals

and human factors:

1. Chemical factors (respiratory disorders of skin irritation, even poisoning, and flammable materials)
2. Human and Organizational Factors (discipline of workers who are still lacking)
3. Effectiveness of Risk Analysis Methods (Identifying Complex Hazard Scenarios)
4. Implications (Implementation of Comprehensive Chemical -Based Work Safety Risk Management.

CONCLUSION

Occupational Safety and Health (K3) is an important aspect to prevent work risks and accidents, especially those caused by human and environmental factors. Human factors are the dominant cause of work accidents due to lack of discipline and understanding of the application of K3 according to SOP. K3 training has been proven to be effective in increasing workers' understanding, shown by the increase in test results from pre-test to post-test, so that it has a positive impact on work safety awareness, company image, sense of ownership, and work efficiency.

The commonly used risk analysis methods are Hazop, FMEA, and ISO 31000, as well as the application of risk control hierarchy (elimination, substitution, technical control, administrative, and PPE).

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